Utilizzo del protocollo SIP a supporto di applicazioni di rete avanzate in ambienti eterogenei

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Sommario

1. Il protocollo SIP
   - Origini: VoIP
   - Evoluzione e Convergenza: IMS
   - Panoramica del protocollo
2. Architettura di rete collaborativa basata su SIP
   - integrazione tra modello centralizzato e peer-to-peer
3. Segnalazione SIP per GRID over OBS
   - Optical Burst Switching
   - Grid Networks
   - Il ruolo di SIP

Sommario

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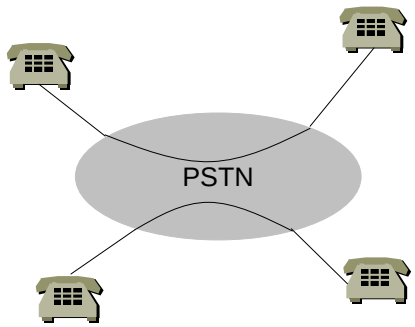
3

Telefonia tradizionale

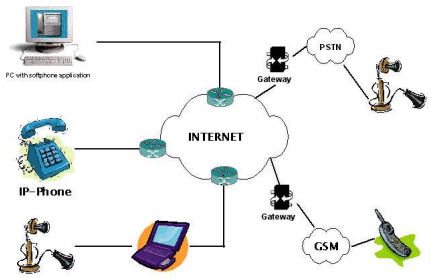
- Commutazione di Circuito
- Vantaggi:
  - “Certezza” della comunicazione
  - Qualità garantita
- Svantaggi:
  - Infrastruttura dedicata
  - Tariffazione “gerarchica” in funzione della distanza
  - Pochi servizi aggiuntivi



4

Voice over IP (VoIP)

- Commutazione di pacchetto
  - Si utilizza la rete dati
    - integrazione con Internet
- Vantaggi
  - Integrazione del sistema telefonico con il sistema informativo
  - Riduzione costo chiamate
  - Abilitazione a nuovi servizi
  - Mobilità
- Svantaggi:
  - Qualità non garantita
    - Ritardo e Percorso non specificato
    - Perdita di pacchetti
  - Modifica delle architetture di rete
  - Sicurezza



5

Integrazione su rete IP: oggi

- Dell'infrastruttura
  - ☺Maggiore economia di scala
  - ☺Unitarietà di gestione
  - ☹Vulnerabilità
- Dei servizi
  - ☺L'utente "vede" un accesso alla rete unificato
  - Servizi diversi = diversi requisiti
  - La rete deve disporre di meccanismi per
    - Distribuire le risorse in conformità alle necessità del servizio
    - Gestire le richieste dei vari servizi senza farle interferire
  - ☹*Questi problemi sono complessi e sulla rete Internet sono ancora parzialmente irrisolti*

6

Integrazione su rete IP: domani

- IP Multimedia Subsystem (IMS):
  - Integrazione fra reti IP e reti wireless
  - Sistema di segnalazione unificato
    - **Session Initiation Protocolo (SIP)**
  - Roaming dei servizi da rete a rete
  - Gestione della qualità del servizio in funzione del tipo di accesso
- Parte integrante di UMTS

7

Applicazione del VoIP

- IP trunking
  - Tecnologia IP (commutazione di pacchetto) su collegamenti della rete di trasporto
  - Non ha impatto sulla rete di accesso e sull'utente
    - I terminali sono quelli tradizionali
  - Può avere impatto sulla tariffazione
- Telefonia IP
  - Tecnologia IP per la fornitura del servizio di telefonia
  - Ha impatto sulla rete di accesso e sulla rete di trasporto
    - Terminali di utente IP
    - Segnalazione IP
    - Gestione su rete IP

8

Implicazioni del VoIP

- Reti pubbliche
  - Rete di accesso - utente finale
    - Si usa il collegamento dati (tipicamente ADSL) per avere accesso a servizi di telefonia
  - Operatore
    - IP trunking sulla rete di trasporto degli operatori
- Reti private
  - Integrazione del trasporto delle informazioni fra sedi: IP trunking
  - Integrazione dell'accesso ai servizi di comunicazione del personale
    - Una presa non due sulla scrivania
  - Sostituzione dei centralini tradizionali con centralini "software"
  - Integrazione dei servizi vocali con servizi dati
    - Messaggistica istantanea
    - Voice-mail
    - Servizi di presenza

9

Tecnologie VoIP attuali

- Standard IETF basato su protocollo SIP
  - Maggiore semplicità rispetto ad H.323
  - Struttura gerarchica a domini
  - Ogni organizzazione controlla il proprio dominio telefonico
  - I domini telefonici comunicano tramite rete IP
- Skype, basato su protocollo proprietario
  - Tecnologia P2P
  - Tutti gli utenti appartengono alla stesse rete
  - Non gerarchico, poco adatto per essere integrato in una struttura aziendale

10

Il caso dell'Università di Bologna

- Rete telefonica e rete dati distribuite su tutta la Provincia di Bologna e la Romagna
  - Più di 50 sedi con centralini telefonici
  - Circa 1000 numeri telefonici
- Evoluzione
  - Ieri: rete telefonica tradizionale
    - Centralini + CDN per l'interconnessione + linee di accesso alla PSTN
  - Oggi: rete ibrida
    - Centralini + IP trunking + linee di accesso alla PSTN
  - Domani?
    - Scelte opportunistiche in funzione della convenienza economica e gestionale

11

Next Generation Network standards

- 3GPP ha sviluppato un sistema completo per le reti mobili (IMS)
  - Architettura SIP completa
  - Sviluppata sulle specifiche delle estensioni dei protocolli IETF
  - 3GPP non indica come estendere l'architettura IMS
- Le reti fisse NGN sono il risultato del lavoro di differenti organizzazioni
  - ETSI, ITU-T hanno costruito l'architettura di base, IETF ha fornito i protocolli
  - ATIS ha collaborato con ETSI TISPAN per l'architettura IMS su rete fissa
  - MSF ha definito l'implementazione fisica vs. logica
  - DSL Forum ha considerato gli aspetti di economici e di mercato

12

IMS - IP Multimedia Subsystem

- IMS si propone di creare la convergenza tra servizi e reti
- Ha lo scopo di permettere di usare qualsiasi servizio su qualsiasi dispositivo in ogni rete
- Progettata per permettere veloci sviluppi dei servizi
- Provider di servizi di telefonia mobile:
  - IMS è stata creata per “qualsiasi necessità” di servizi futuri
  - I servizi sono convergenti: utenza residenziale e di affari
- Provider di servizi di telefonia fissa:
  - Tempi lunghi per rimpiazzare la tecnologia PSTN
  - Deve innovare e rigenerare i servizi di telefonia fissa
    - Aggiungere valore ai servizi esistenti
    - Raggiungere nuovi mercati attraverso la convergenza fisso/mobile
    - Ridurre Opex

13

La sfida dell’integrazione

- Estendere l’IMS alle reti fisse introduce molti problemi di interconnessione
  - Indirizzamento
  - Protocolli (soprattutto di segnalazione)
  - Codecs
  - QoS, risorse per banda e servizi
  - Sicurezza
  - …

14

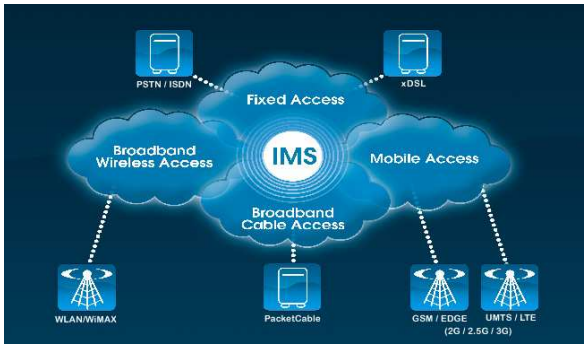
TISPAN

- Nata nel 2003 da SPAN e TIPHON
- Standard per Next Generation Networks (NGN)
  - Telecoms & Internet convergence
- Costruita sulla tecnologia 3GPP IMS
- È una rete IP multi-servizio, multi-protocollo, multi-accesso
  - sicurezza, riusabilità
- Permette ai Service Provider di offrire:
  - Servizi di comunicazione real-time e non real-time
  - Modelli sia di tipo P2P che Client-Server
- Mobilità

15

3GPP/TISPAN

- Requisiti molto stringenti nel border control:
  - Sicurezza
  - Autenticazione
  - Policing
- WiFi , WiMAX hanno bisogno dello stesso tipo di controllo



16

Architetture convergenti

- 3GPP ha definito IMS
  - http://www.3gpp.org
- ETSI TISPAN sta definendo l'accesso alla rete IMS per la telefonia fissa
  - http://www.etsi.org/tispan

17

Session Initiation Protocol (SIP)

- Application layer protocol
- Independent of the transport layer
- Based on domains
- Application-layer call signaling
  - Set-up, modification, termination
  - Negotiation of adopted media
    - Session Description Protocol (SDP)
  - Re-negotiation during session
  - User location → personal mobility
  - Security
  - Supplementary services

18

IETF RFCs related to SIP (1/2)

- Base spec RFCs related to SIP
  - **RFC 3261: SIP: Session Initiation Protocol**
  - **RFC 3263: Locating SIP Servers**
  - **RFC 3264: An Offer/Answer Model with SDP**
- Extended Features
  - RFC 2976: The SIP INFO Method
  - RFC 3262: Reliability of Provisional Responses in SIP
  - RFC 3265: SIP-specific Event Notification
  - RFC 3311: SIP UPDATE Method
  - RFC 3312, RFC 4032: Integration of Resource Management and SIP
  - RFC 3326: Reason Header
  - RFC 3327: Registering Non-Adjacent Contacts
  - RFC 3428: Instant Messaging
  - RFC 3487: Requirements for Resource Priority
  - RFC 3515: SIP REFER Method
  - RFC 3581: Symmetric Message Routing
  - RFC 3680: SIP event package for registrations
  - RFC 3725: Third-party Call Control (3PCC)
  - RFC 3840, 3841: Callee capabilities and caller preferences
  - RFC 3842: Message waiting indication / message summary
  - RFC 3857, 3958: Watcher Information event package + XML format
  - RFC 3891: Replaces: header
  - RFC 3892: Referred-By: header
  - RFC 3903: Event state publication (SIP PUBLISH method)
  - RFC 3911: Join: header
  - RFC 4028: Session timers
  - RFC 4168: SCTP as transport protocol

19

IETF RFCs related to SIP (2/2)

- Security
  - RFC 3323: A Privacy Mechanism for SIP
  - RFC 3325: Private Extension for Asserted Identity in Trusted Networks
  - RFC 3329: Security-Mechanism Agreement for SIP
  - RFC 3603: Proxy-to-Proxy Extensions
  - RFC 3702: AAA requirements for SIP
  - RFC 3853: S/MIME AES
  - RFC 3893: Authenticated Identity Body
- Others
  - RFC 3665, 3666: SIP Call Flows
  - RFC 3361: DHCP Option for SIP Servers
  - RFC 3608: Service Route Discovery
  - RFC 3398, 3578: ISUP and SIP Mapping
  - RFC 3420: Internet Media Type message/sipfrag
  - RFC 3427: SIP Change Process
  - RFC 3455: Header Extensions for 3GPP
  - RFC 3485, 3486: SIP header compression
  - RFC 3764, 3824: Using ENUM with SIP
  - RFC 3959: Early Session disposition type (early-session, session)
  - RFC 3960: Early Media and Ringing Tone Generation
  - RFC 3968, 3969: IANA SIP header field and URI registry
  - RFC 3976: SIP – IN Interworking
  - RFC 4117: 3rd party call control invocation of transcoding services
  - RFC 4123: SIP – H.323 Interworking requirements

20

What SIP is not

- Intended for session control by itself
  - No flow control
  - No participant lists
  - No policies, voting, …
- Designed for distribution of multimedia data
- A generic transport protocol!
- Another RPC mechanism
  - Is not a general request&answer protocol
- Something to put into every device on the planet
  - Not part of a general IP infrastructure (yet?)
  - Nevertheless: application layer routing gets more and more important

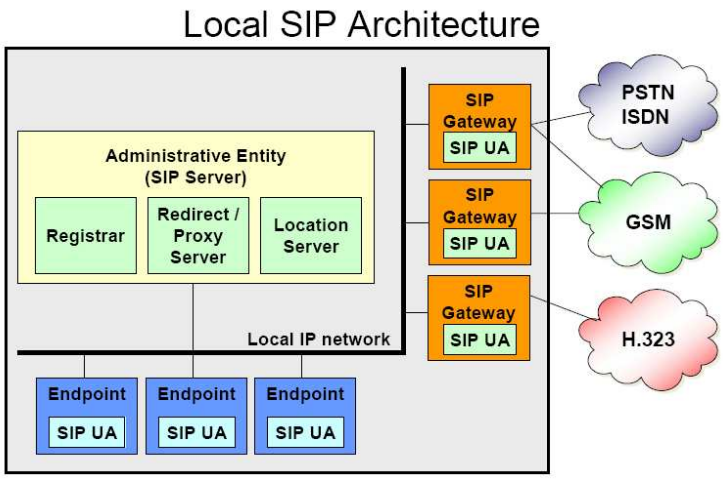
21

Base Terminology

- User Agent Client (UAC):
  - Endpoint, initiates SIP transactions
- User Agent Server (UAS):
  - Handles incoming SIP requests
- Redirect server:
  - Retrieves callee's addresses and returns them to caller
- Proxy (server):
  - Autonomously processes and routes requests
    → forward incoming messages (limited modifications only)
- Registrar:
  - Stores explicitly registered user addresses
- Location Server:
  - Provides information about a target user's location
- Back-to-Back User Agent (B2BUA)
  - Keeps call state; more powerful intervention than proxy

22

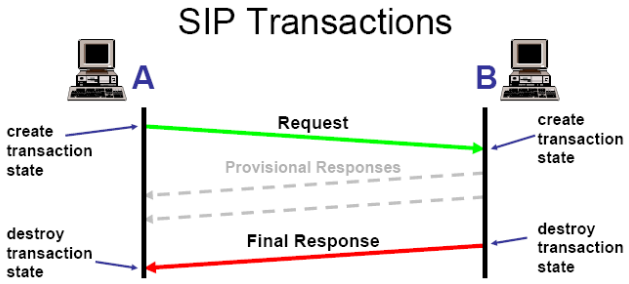
Architecture



Protocol Characteristics

- Transaction-oriented
  - Request–response sequences
- Independent from lower layer transport protocol
  - Works with a number of unreliable and reliable transports
    - UDP, TCP, SCTP
    - Secure transport: TLS over TCP, IPSec
  - Uses retransmissions to achieve reliability over UDP
  - Optionally uses IP multicast/anycast service
- Independent of the session to be (re-)configured
- Re-use syntax of HTTP 1.1
  - Text-based protocol (UTF-8 encoding)
- Servers maintain minimal state info
  - Stateless proxies
  - Transaction-stateful proxies
  - Dialog (call) state in endpoints (optional for proxies)

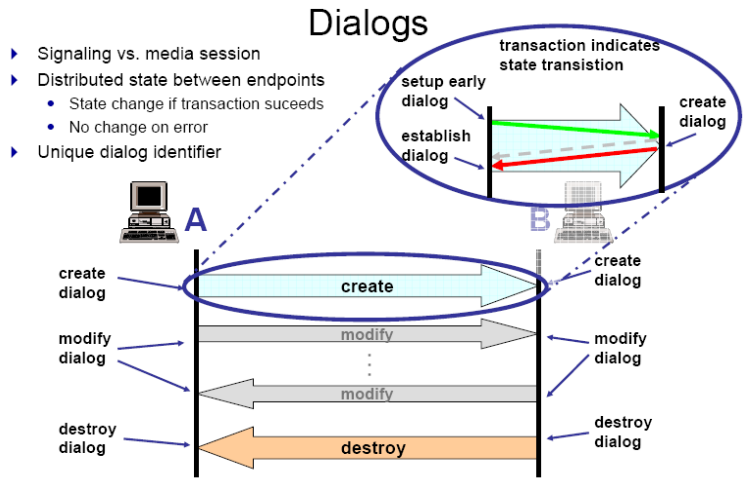
Transactions



- RPC-like approach:
  - Initial request
  - Wait for final response
- Provisional responses:
  - Additional status information
  - May be unreliable
- Unique identifier (transaction id) **(originator, recipient, unique token, sequence number, ...)**
- Independent completion

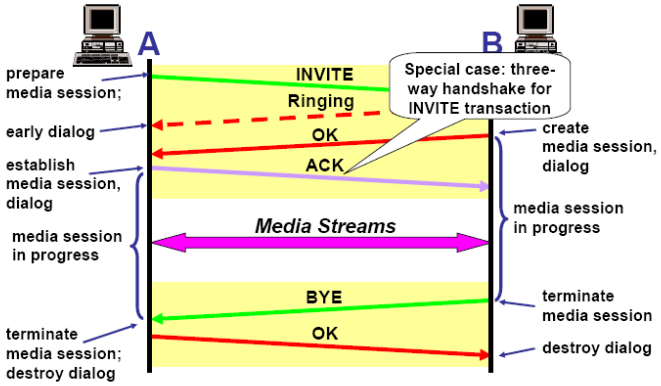
25

Dialogs



26

Dialog example



Request Message Syntax

Start line

```
INVITE sip:user@example.com SIP/2.0
```

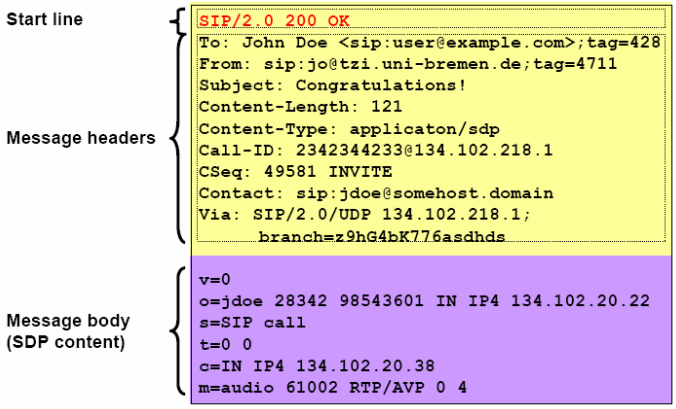
Message headers

```
To: John Doe <sip:user@example.com>
From: sip:jo@tzi.uni-bremen.de;tag=4711
Subject: Congratulations!
Content-Length: 117
Content-Type: applicaton/sdp
Call-ID: 2342344233@134.102.218.1
CSeq: 49581 INVITE
Contact: sip:jo@134.102.224.152:5083
          ;transport=udp
Via: SIP/2.0/UDP 134.102.218.1;
      branch=z9hG4bK776asdhds
```

Message body (SDP content)

```
v=0
o=jo 75638353 98543585 IN IP4 134.102.218.1
s=SIP call
t=0 0
c=IN IP4 134.102.224.152
m=audio 47654 RTP/AVP 0 1 4
```

Response Message Syntax



29

SIP URI Addressing Scheme (**sip: / sips:**)

- Follows basic URI syntax (RFC 2396)
- Separates names (permanent) and addresses (temporary)
  - Basic mobility support
- Two roles reflected in SIP
  - Naming a user; typically **sip:user@domain**
  - Contact address of a user; typically contains host name or IP address, port, transport protocol, ...
- URIs may carry additional parameters
- URIs may also identify services

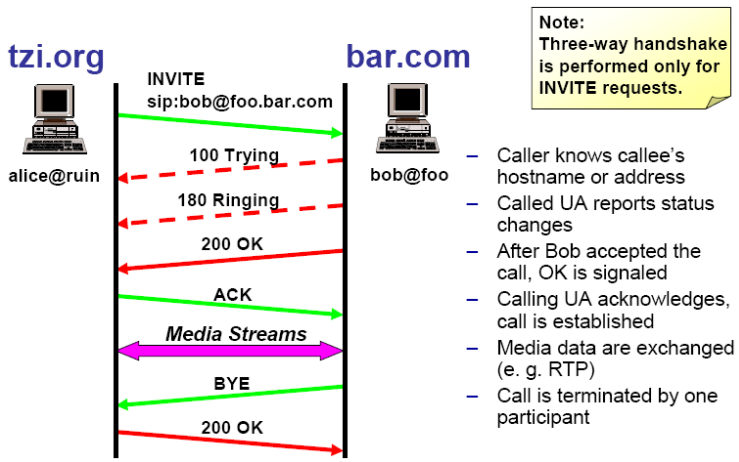
30

SIP URI Addressing Examples

- Registration domain or IP address
  - sip:tzi.org
  - sip:192.168.42.1
- SIP URI to call (Address of Record)
  - sip:john@example.com
- SIP Contact Address (actual user location)
  - sip:john@host1.example.com
  - sip:john@192.168.42.9:9950
- Service identifier; semantics opaque to the user
  - sip:voicemail@service.com
  - sip:conf-1234@confserv.com
  - sip:user34@anonymizer.org
- URI parameters may carry detailed information on specific URI components:
  - sip:john@Example.COM;maddr=10.0.0.1
  - sip:+1555123456@tel-gw.myitsp.com;user=phone

31

Direct call



- Caller knows callee's hostname or address
- Called UA reports status changes
- After Bob accepted the call, OK is signaled
- Calling UA acknowledges, call is established
- Media data are exchanged (e. g. RTP)
- Call is terminated by one participant

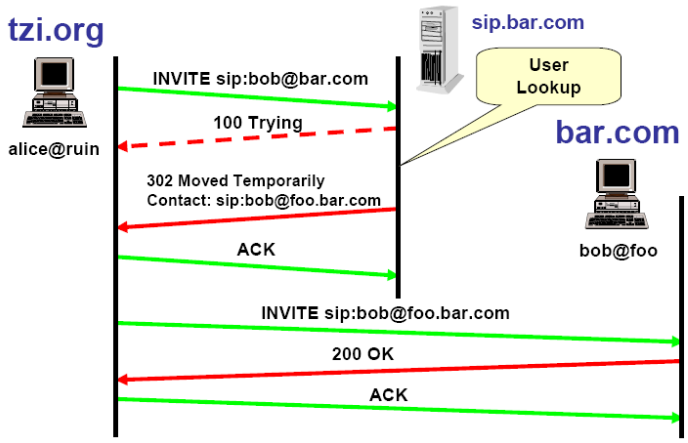
32

How to Find The Callee

- Direct calls require knowledge of callee's address
- SIP provides abstract naming scheme:
  - **sip:user@domain**
- Define mapping from SIP URI to real locations:
  - Explicit registration:
    - UA registers user's name and current location
  - Location service:
    - Use other protocols to find potentially correct addresses
- Caller sends **INVITE** to any SIP server knowing about the callee's location
- Receiving server may either *redirect*, *refuse* or *proxy*

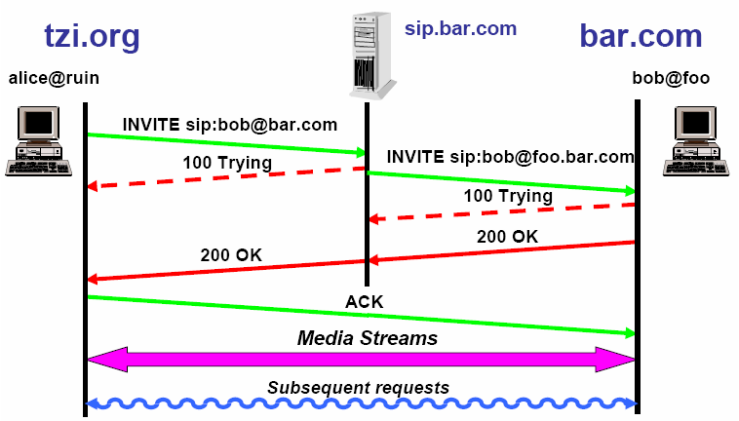
33

Redirected Call



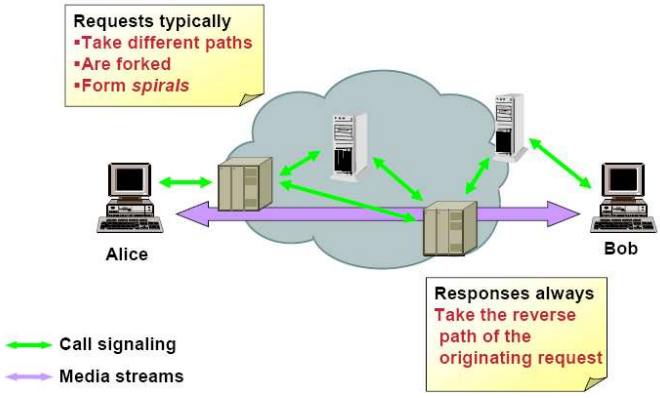
34

Proxied Call



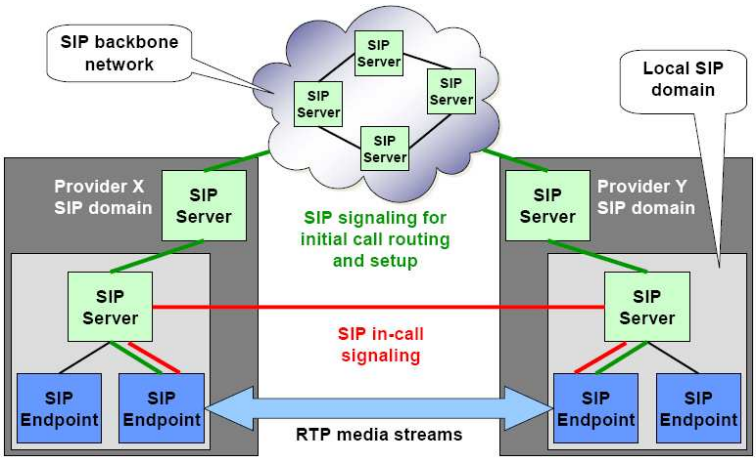
35

Proxied Call (Real World)



36

Global SIP Architecture



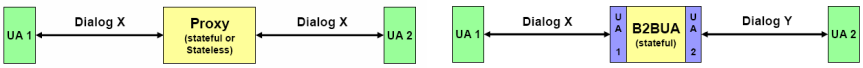
37

SIP (Proxy) Server Functions

- Stateless vs. stateful
  - Stateless: efficient and scalable call routing (backbone)
  - Stateful: service provisioning, firewall control, ...
- Some roles for proxies
  - Outbound proxy
    - Perform address resolution and call routing for endpoints
    - Pre-configured for endpoint (manually, DHCP, ...)
  - Backbone proxy
    - Essentially call routing functionality
  - Access proxy
    - User authentication, authorization, accounting (AAA)
    - Hide network internals (topology, devices, users, etc.)
  - Local IP telephony server (IP PBX)
  - Service creation in general
- **More elaborate functions provided by Back-to-Back User Agents (B2BUAs)**

38

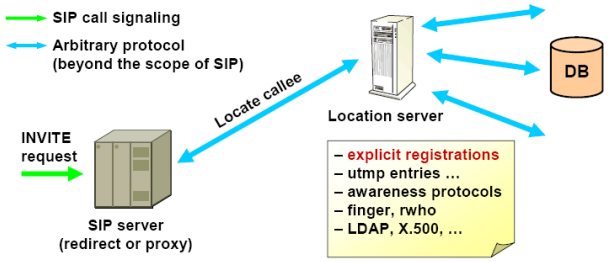
Proxy vs. B2BUA



- Proxies only route and forward requests on behalf of UAs, they do not get active by themselves.
- B2BUAs terminate dialogs. They may create the illusion of an end-to-end dialog by coupling two dialogs and forwarding messages transparently between UAs. But they are a party to both dialogs.

39

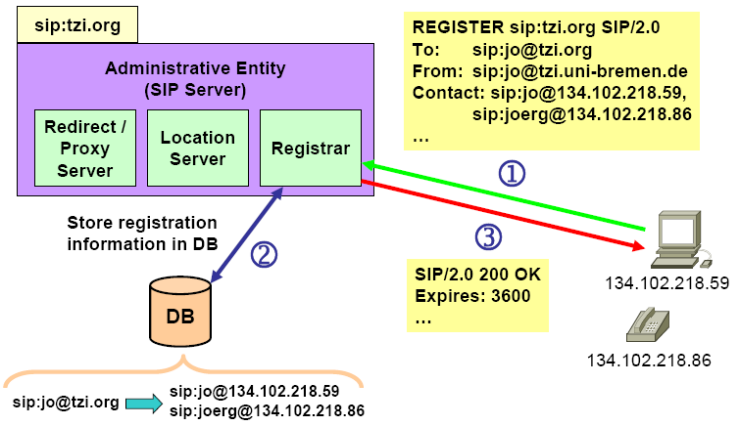
User Location



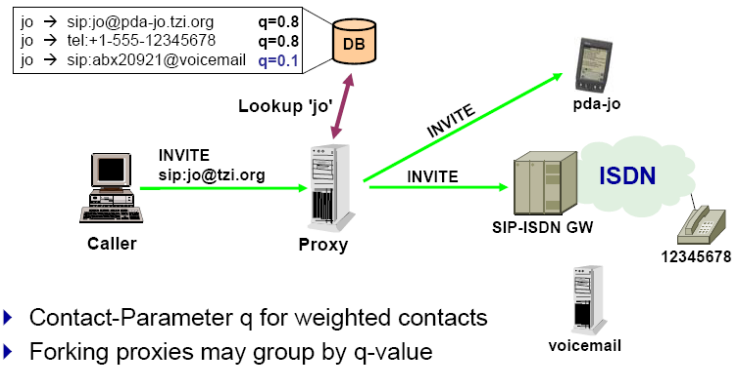
- SIP server asks location server where to find callee
- Location server returns list of contact addresses
- SIP server proxies or redirects request according to address list

40

User Registration

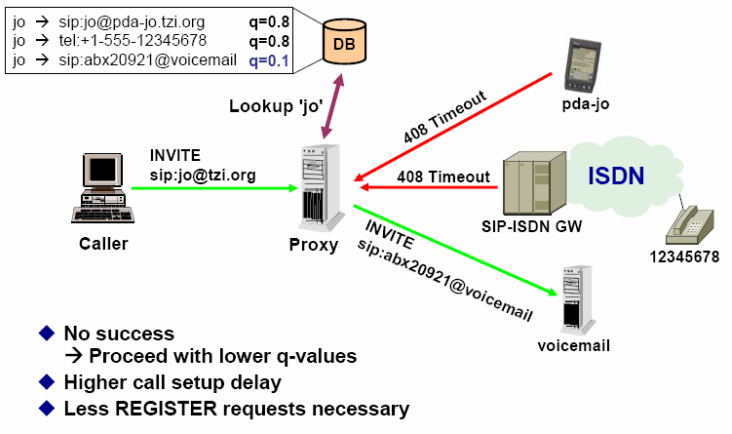


Parallel vs. Sequential Forking (1/2)



- Contact-Parameter q for weighted contacts
- Forking proxies may group by q-value
  - example: call voicemail system only if no answer from other UAs

Parallel vs. Sequential Forking (2/2)



43

Basic Extension Mechanisms

- Proxies forward unknown methods and headers
- UAs ignore unknown headers, reject methods
- Feature negotiation
  - Headers: Require, Proxy-Require, Supported
  - Option tags for feature naming (see below)
  - Error responses:
    - 405 Method not allowed
    - 420 Unsupported
    - 421 Extension Required
- Option tags
  - Identified by unique token
  - Prefix reverse domain name of creator
  - IANA: implicit prefix *org.ietf.*

44

Some Current SIP Extensions

- Reliable provisional responses
- Session Timers
- Early Media
- Adjusting session state: UPDATE
- INFO method
- REFER peers to third parties
- SIP for subscriptions and event notifications
- Instant messaging
- SIP for presence

45

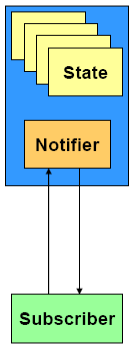
Event Notifications

- Need for flexible event notification
  - Enable presence information
  - Better support for mobile SIP applications
  - Feedback about progress of other calls, conference state, etc.
  - NOTIFY method, Event: header
- Event subscription
  - SUBSCRIBE, Event:
  - Events may be call-related or third-party generated
  - Security issues: Sensitive Events
    - Privacy
    - Authentication
- Used for personal presence applications
  - Used with PUBLISH method to update presence state
  - Augmented by MESSAGE method for Instant Messaging

46

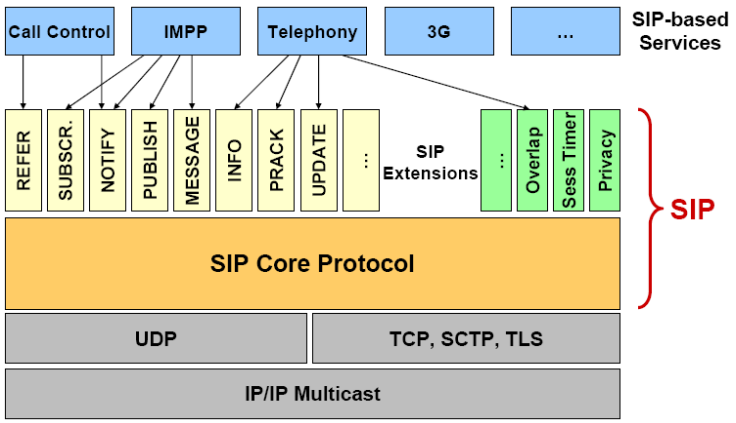
Event Concept

- Piece of state information S
  - Identified by some name ("package")
- SIP entities interested in S
  - Query for the current state
    - "polling"
  - Be notified about changes to S
    - SUBSCRIBE
  - Subscriptions may be created implicitly
    - By means of other (SIP or non-SIP) protocol activity
- Information about S carried in message body
  - NOTIFY
  - Formats to be defined specific to S
- Protection of S
  - Keep control of who gains access, who has access; for how long



47

SIP Service Creation Model



48

Sommario

1. Il protocollo SIP
   - Origini: VoIP
   - Evoluzione e Convergenza: IMS
   - Panoramica del protocollo
2. Architettura di rete collaborativa basata su SIP
   - integrazione tra modello centralizzato e peer-to-peer
3. Segnalazione SIP per GRID over OBS
   - Optical Burst Switching
   - Grid Networks
   - Il ruolo di SIP

49

Integrated Network Models

- IMS (centralized)
  - Fixed organization
  - Service Provider controls the users
    - Efficient
    - High cost of ownership in terms of resource and bandwidth
- P2P (distributed)
  - Self organizing
  - Users “are” the network
    - Scalable infrastructure
    - Minimal cost of ownership, users share resources and bandwidth

50

Features

- Centralized (Service Provider)
  - Advantages
    - Centralized management, efficient
    - Short time to established a call connection, easy user location
  - Issues
    - Many resources
    - Mobility management, message routing through proxy
    - Vulnerability attack
    - QoS, etc…
- Distributed (P2P)
  - Advantages
    - No central administration
    - No QoS, etc…
    - Users share resources
  - Issues
    - Slow call connection, user location O(log(N))
    - Service provisioning
    - Security and privacy

51

Mobility

- Centralized architecture efficient for management but not for connectivity
  - Proxy has a fixed location
    - Messages routed through proxy
    - Streams routed through proxy
- Today mobility means roaming across connectivity islands
  - LANs, Wi-Fi hot spots, WiMax cells, GSM, UMTS etc…
  - Large variety of access networks and administrative entities
- Service provisioning in case of user location change
- Exploit ease of location inside an “island”
  - Fast provisioning of emergency call capability

In this scenario resources (Users/Domains) must cooperate with the network

52

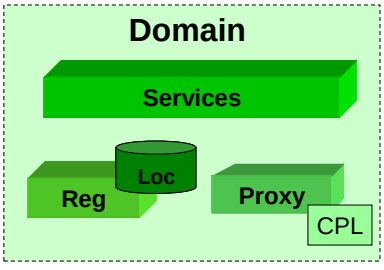
Cooperative network

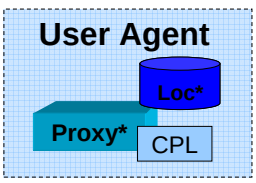
- The aim is to take the best of the two worlds
  - Centralized administration
  - Distributed connectivity
- Cooperative network
  - Based on domains (Different administrative entities)
    - All the decisions are taken by domains
  - As in p2p, all the network entities (proxies/peers) can share resources and connections
- Based on SIP protocol
- Can be integrated with the existent SIP network
- **The final goal is to build a "network of cooperating peers/domains" supporting users mobility and providing the "best service" available at any time.**
- A SIP user exploits the whole SIP infrastructure for communication

53

Network elements

- Call Processing Language (CPL)
  - Standard language for storing the call/service preferences
- Home/Foreign domains
  - AAA
    - Registrar
  - Location
  - Proxy (CPL)
  - Services
- Users Agent
  - Message forwarding
    - Proxy* (CPL)
  - Location*





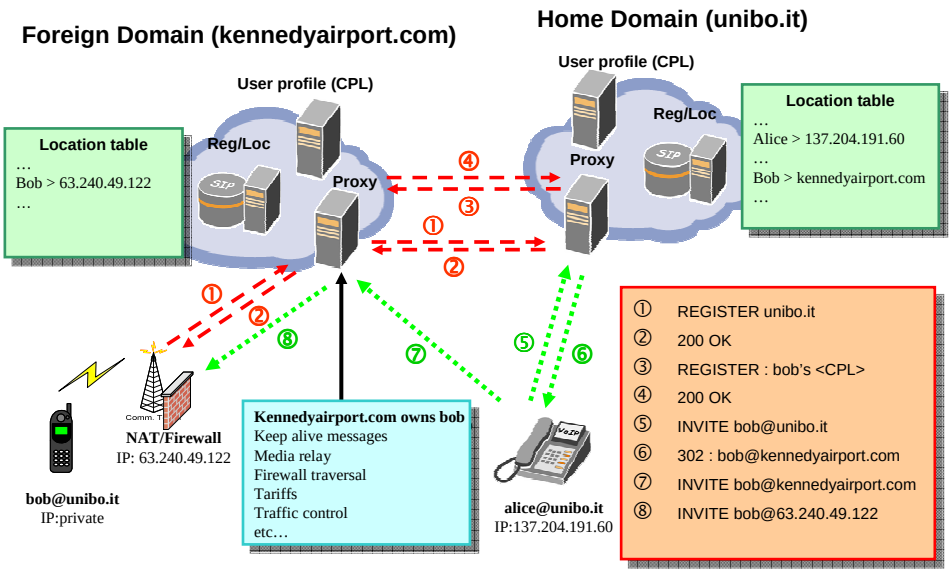
54

Network connection (1/2)

- Domains share users
  - Home domain
    - Provides user administration
    - Manages
      - connectivity
      - location/registration
    - Maintains User preferences (CPL)
    - Provide services (voicemail, etc…)
  - Foreign domains can provide the user with connectivity
    - Registration of a foreign user allowed
    - To provide connectivity, user's CPL is needed
  - Users can connect to any proxy to enter the network
    - A copy of CPL is moved to the chosen proxy from the Home Domain
- Users share connection

55

Domains share users



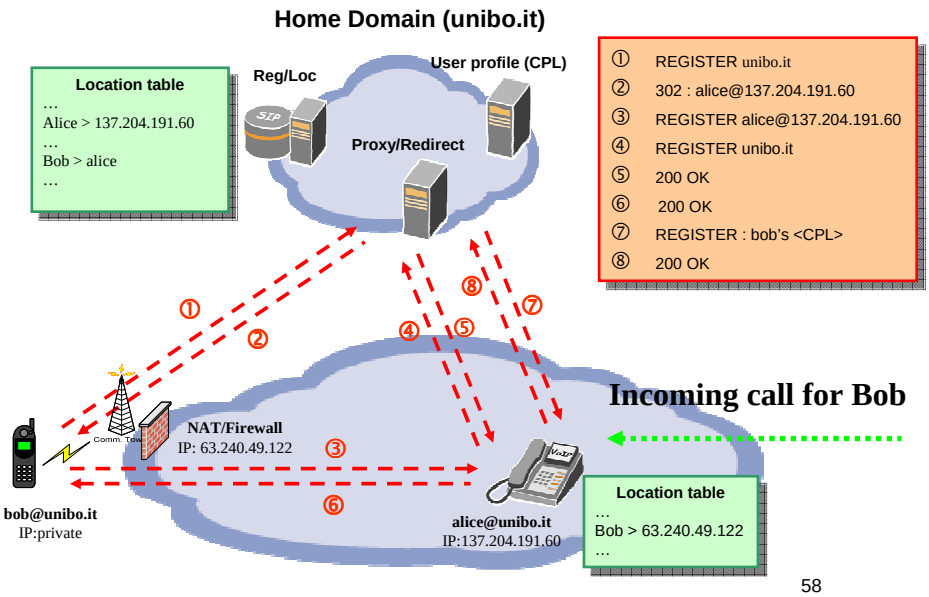
56

Network connection (2/2)

- Domains share users
- Users share connection
  - Users share their own resources and bandwidth with other users
  - User Agents (UAs) are equipped with :
    - Proxy* (CPL): capability to route messages according to CPL
    - Location server*: store the position of the peers
  - UAs can accept registration from other users
  - Most of the calls are provided by the buddies (peers)
    - UA implements a Proxy* and a Location server*
    - We can use presence messages to deliver the location to the buddies

57

Users share connection



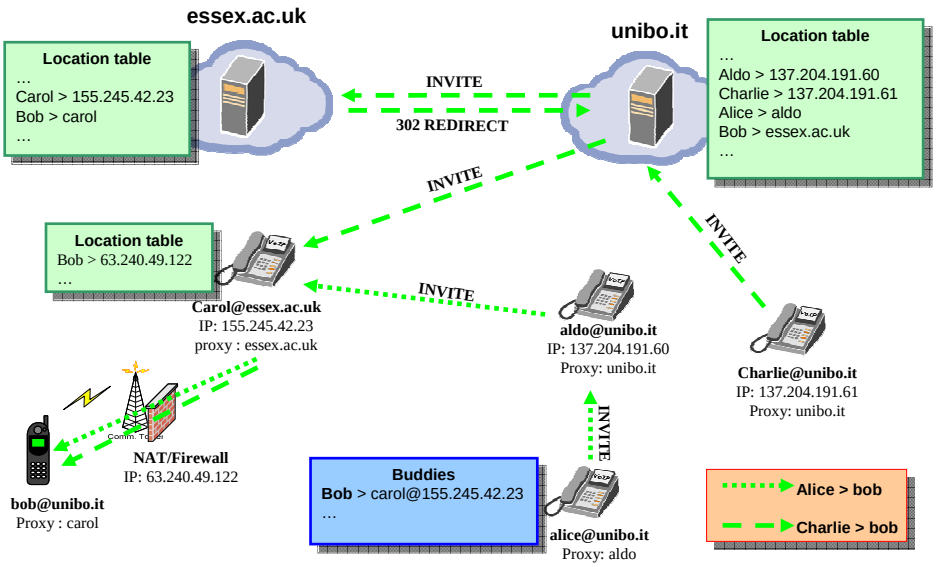
58

Features

- Providers viewpoint
  - Domains are able to “delegate the work” to a user or to another domain
    - Save resources, reduce bandwidth
  - Domains still provide user registration, location and management
  - Mobility islands can control the VoIP traffic
    - Call rating, security, etc…
- Users viewpoint
  - Messages are routed by the “nearest” proxy
    - Less latency, efficient use of bandwidth
  - Users agree to share resources and bandwidth
  - Call set-up time should be as short as possible (less than 3 sec.)
  - User can be easily located into an island
    - Emergency call

59

Example



60

Wrap-up

- Cooperative Network
  - "Best service available" everywhere
  - Users/Domains exploit at its best the networking infrastructure
  - Optimization
    - VoIP service is provided by closest peer according to the user's CPL
- Service Providers and Users can take advantage
- Can be integrated in the existing SIP network
  - Standard SIP messages

61

Issues

- Security
  - All messages must be secured
- Privacy
  - CPL is sent over the network
- Features
  - Domains share users: small modifications to the proxy
  - Users share connection: put small proxy and location server capabilities into UAs
- Need for a standard description language for call and service preferences
  - is CPL enough?

62

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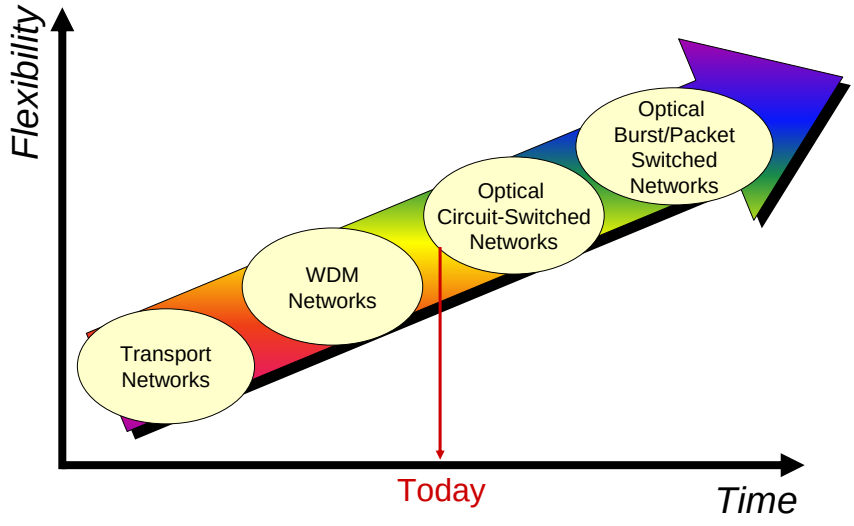
63

Optical Networking Evolution

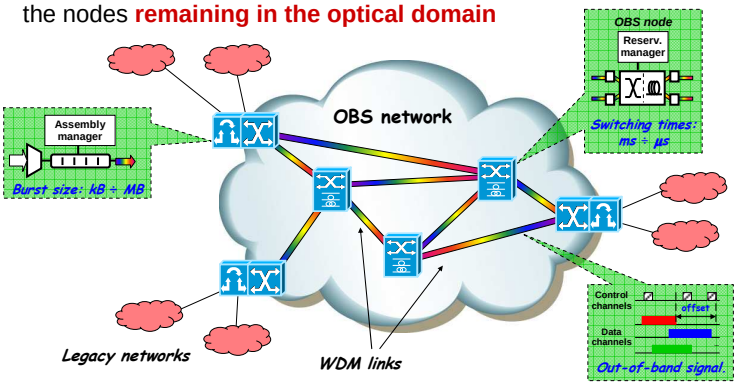


Optical Burst Switching (OBS): a trade-off between OCS and OPS

64

OBS network

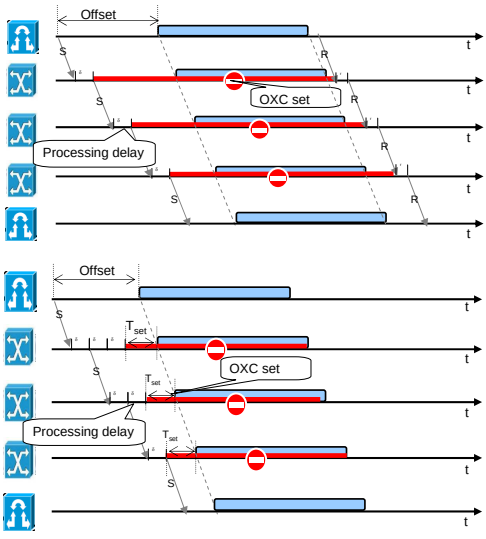
- Control and data information travel **separately** on different channels
- Data coming from legacy networks are aggregated into a **burst unit** in edge node
- The **burst control packet (BCP)** is sent first, in order to reserve the resources in intermediate nodes
- The burst follows the control packet after some **offset time** and it crosses the nodes **remaining in the optical domain**



65

Tell-and-go OBS signaling

- JIT (Just in Time) protocol:
  explicit setup and explicit or implicit release
- Horizon and Just Enough Time protocols:
  employ estimated setup and estimated release
  - Horizon doesn't support void filling
  - JET supports void filling



66

OBS as an infrastructure for GRID computing

- Provides the capacity and flexibility required by grid applications
- Intelligent routers
  - BCP
  - Data burst
  - Active burst
- Access to GRID
  - Grid User Network Interface (GUNI)
    - Service Invocation
    - Bandwidth allocation
    - AAA
  - Grid Resource Network Interface (GRNI)
    - Extension of GUNI
    - Job submission
    - Support for advantage reservation schemes
    - Propagation of resource state
    - Bandwidth allocation for returning burst (response from one or many destinations)

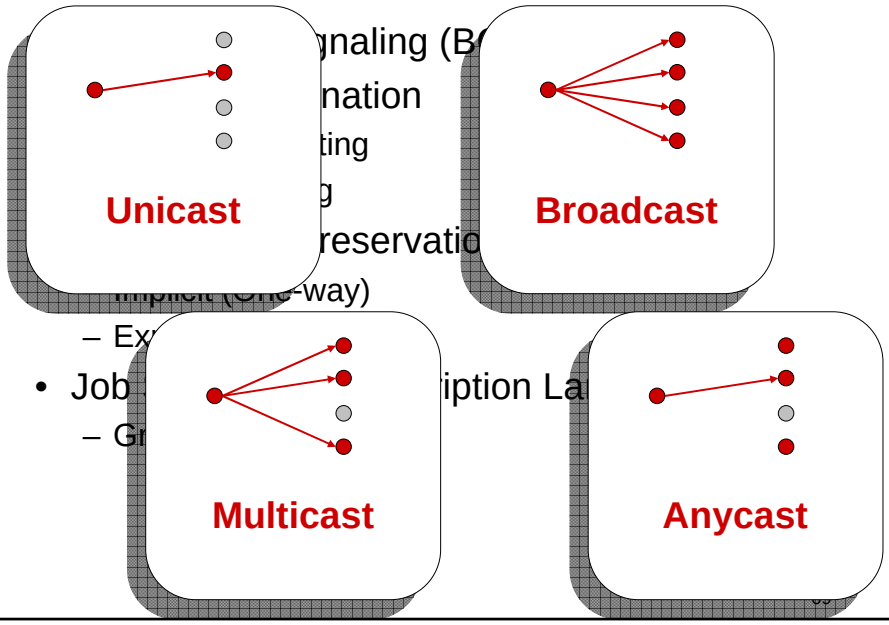
67

Discovery and reservation

- Out-of-band signaling (BCP for GRID)
- Resource destination
  - Traditional routing
  - Anycast routing
- Discovery and reservation
  - Implicit (One-way)
  - Explicit (Two-way)
- Job Submission Description Language (JSDL)
  - Grid Forum Draft 1.0

68

Discovery and reservation



Signaling in GRID nets

- **Objective**: to adopt an existing signaling scheme capable to fulfill all grid service requirements without major modifications

- Need to:
  - choose a suitable protocol
  - identify a suitable set of protocol functions
  - define a suitable functional architecture

Why don't we try with SIP ?

70

SIP for GRID

- Resource discovery and reservation
  - SIP in which layer?
  - In-band or out-of-band?
- Standard SIP or extension for GRID?
  - Call flow
  - Request and response messages
  - SIP server: proxy, redirect etc.
  - JSDL vs. SDP
- SIP gateway for optical network (OBS, MPLS)?
- Applications use SIP

71

Architecture

- UAs are users and resources
- Divided into domains
  - Users and resources
- Domains are controlled by **GRID proxies**
  - One or many
- GRID proxy functions
  - Register
  - Proxy (stateful/stateless)
  - Location
  - Redirect
  - IM and Presence server

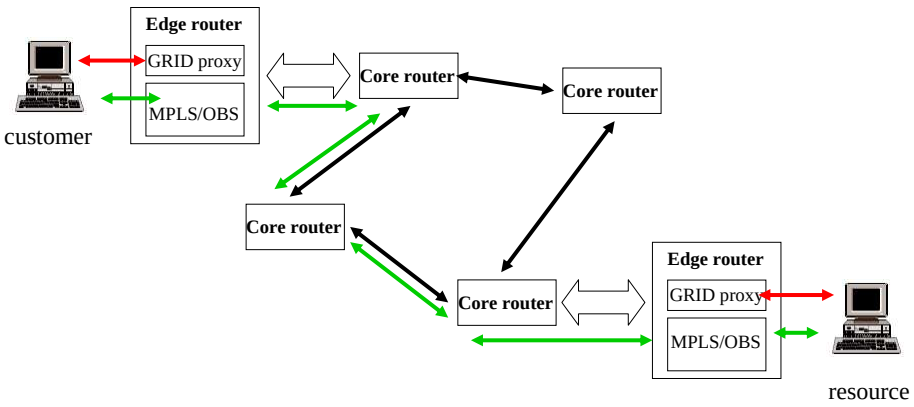
72

Architecture

- Options for GRID proxy into the optical network
  - Edge nodes only
    - Simpler solution
    - Anycast routing only at the application layer
  - Edge and Core nodes
    - Complex solution
    - All types of routing
  - Edge and partially Core nodes
    - Limited functionality in core nodes
    - Modest Complex solution
    - All types of routing (anycast inefficient)

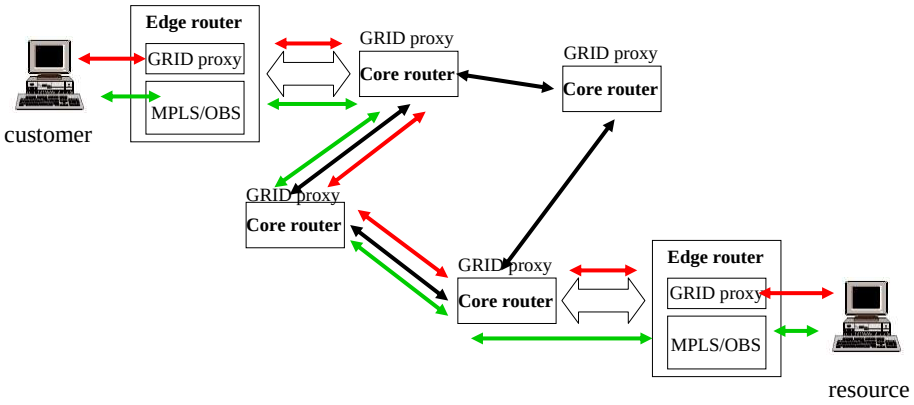
73

Edge nodes only



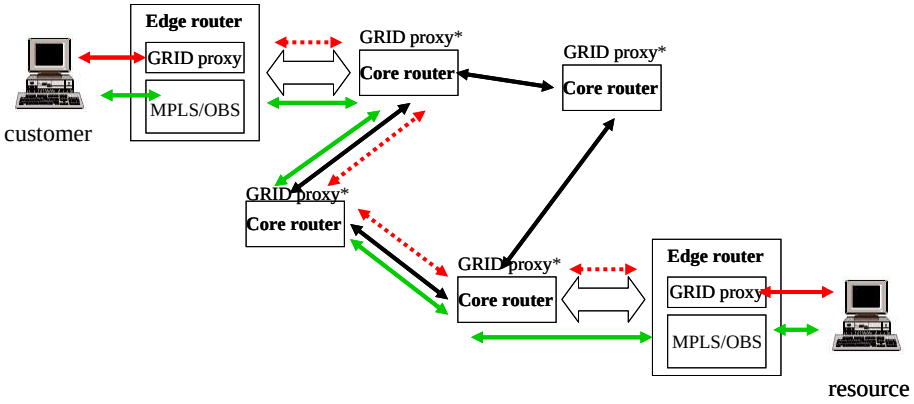
74

Edge and Core nodes



75

Edge and partially Core nodes



76

Architecture (Access)

- Access border control (Edge router)
  - Users and resources
- GRID Proxy
  - Subscription
  - AAA (Authentication, Authorization, Accounting)
- Profiles and QoS
  - Users and resources

77

Resource Discovery and Reservation

- Resource discovery
  - Through SIP methods (PUBLISH, SUBSCRIBE, NOTIFY)
  - Through GRID Proxy (INVITE)
- Reservation
  - Through GRID Proxy (INVITE)
  - Direct request to resource
- Discovery and Reservation
  - One-way (implicit)
    - SIP request
    - GRID Proxy stateful or stateless
  - Two-way (explicit)
    - SIP request and response
    - GRID Proxy stateful or stateless
    - GRID Proxy redirect

78

Resource discovery through SIP methods

- Resources
  - Previously subscribed into Domains
  - Request for registration
  - GRID Proxy may request a SUBSCRIBE
  - PUBLISH the availability to the GRID Proxy
- Users
  - Previously subscribed into Domain
  - Request for registration
  - User may request a SUBSCRIBE
  - GRID Proxy then responds with a NOTIFY
- Availability between Domains
  - With request (Users-Resources)
    - Domain A requests a SUBSCRIBE
    - Domain B responds with a NOTIFY
  - Without request (Resources)
    - Domain PUBLISH the availability
- IMPORTANT: Resources are known inside the network across domains, but not their availability

79

Resource discovery through SIP methods

- NOTIFY
  - Details of availability (intra-domain only)
  - Location of Resources
    - End point or GRID proxy or domain
- GRID Proxy Locator server
  - Resources location
  - Their availability (intra-domain only)
- User reservation
  - On demand
  - Previously reserved
- “Well-known” Network
  - Propagation of PUBLISH and SUBSCRIBE
  - What GRID Proxy doesn’t know, doesn’t exist

80

Resource discovery through GRID Proxy

- User sends INVITE to GRID Proxy
- GRID Proxy doesn't know the destination
  - Re-sends request to known domains
    - Parallel (anycast)
    - Forking
- Location of Domains?
  - Lower layer
    - Multicast
  - Higher layer
    - DNS, p2p, etc…

81

GRID Proxy (1/2)

- Edge nodes only
  - All the information is stored into the GRID Proxy (Well known)
  - Resources Location and Availability
  - Location of Domains in multicast
- Edge and Core nodes
  - Normal GRID Network with SIP protocol
  - Each node can answer or drop a request
- Edge and partially Core nodes
  - In Edge nodes Resources Location and Availability
  - Anycast routing for domain and resource discovery
  - Only Edge node can answer or drop a request

82

GRID Proxy (2/2)

- Controls the OBS/MPLS network
- Provides
  - AAA
  - Resource discovery and Reservation
- SIP extensions
  - Mechanisms for renegotiation
  - Redundancy
  - etc…
- SIP messages carry JSDL
- SIP is used by applications

- **By adopting SIP, we don't need to reinvent the wheel!!!**

83