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A FIRE Project

The Convergence Project.

Enhancing the Internet with a content-centric, publish-subscribe service model, based on a common container for any kind of digital data, including representations of people and Real World Objects

The VDI

- Definition of Versatile Digital Item (VDI)
 - a **standard-based** (ISO-MPEG), self-contained, “all-inclusive” data unit
 - a container for **any kind** of digital data, including media, representations of people and virtual or physical objects (Real World Objects - RWOs)
 - binding of
 - **data** =resources: other VDIs, audio, images, video, text, descriptors of People, descriptors of RWOs, etc.
 - **meta-data**=meta-information describing the content of the item; authentication and protection; rights to use the item; expiry date (supporting “digital forgetting”)
 - VDIs have a unique **identifier**

Wish list

- Create a VDI, defining licenses and rights
- Sign and/or encrypt a VDI
- Search and Retrieve a VDI (metadata ease semantic searches and ease the operation of search engines)
- Publish a VDI
- Subscribe to a VDI (meeting specified criteria)
- Verify the authenticity of a VDI
- Versioning a VDI and linking it to other VDIs
- Update a VDI (my CV, parts catalogue)
- Delete a VDI (digital forgetting and garbage collection)

- Efficiency (Energy Savings)

Alternatives

1. Different Application-layer data units (specific, proprietary)
2. Applications (specific, proprietary)
3. Current Internet

1. A standard unit of distribution and transaction: the VDI
2. Applications/Tools (e.g. VDI Creator, VDI Manager/Browser)
3. Middleware (MPEG-M=powerful content identification and handling)

- publish named VDIs to the network
- subscribe to named VDIs or to VDIs meeting pre-specified search criteria
- search, rights management
- security and privacy mechanisms

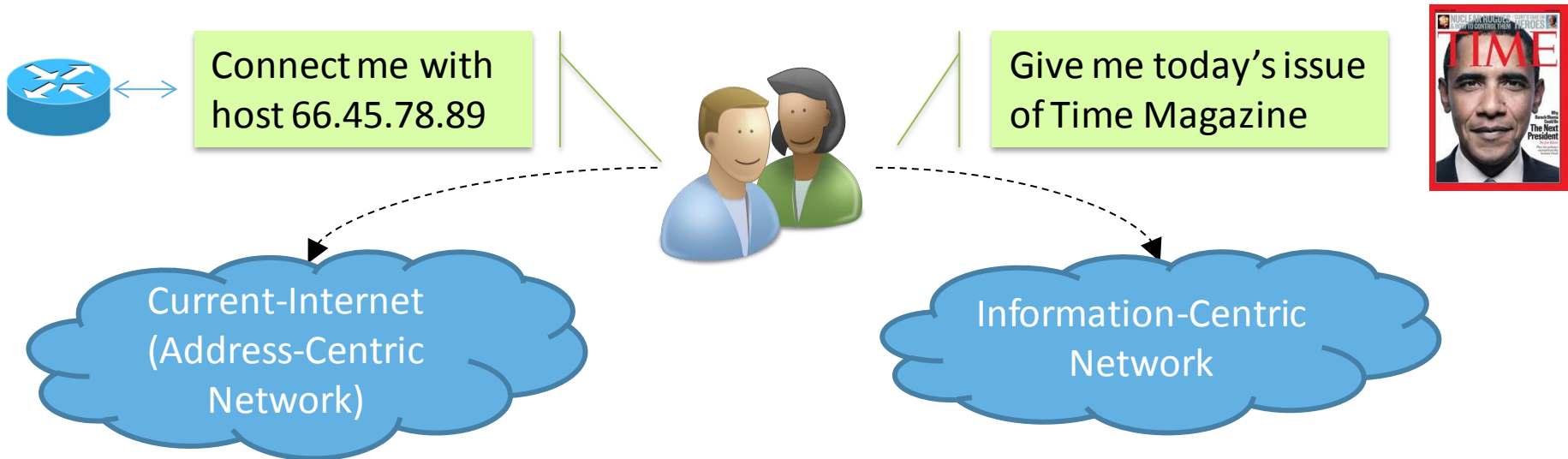
4. Information centric network (=simpler functions at line speed)



Interfaces

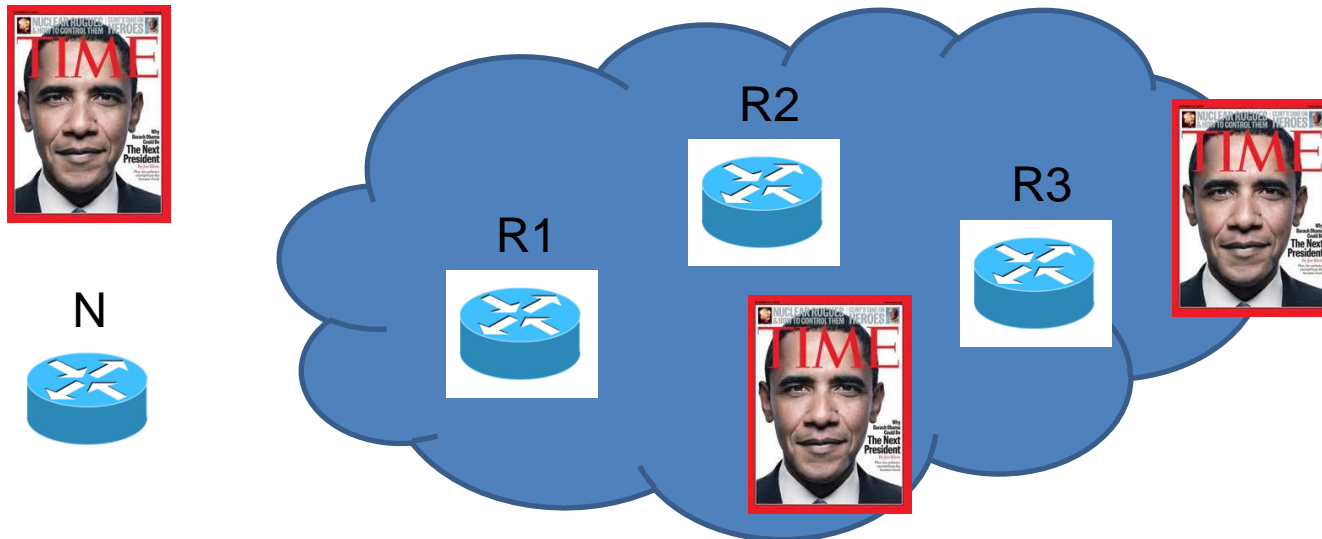
Information Centric Network

- The network layer provides users with contents, instead of providing communication channels between hosts, and is aware of content identifiers



Shift of paradigms

- Circuit Switching, Telephone Network: a PCM slot contains only user data
- Packet Switching, Internet: an IP datagram contains (among other things) destination addresses and pieces of user data
- **Content “Switching”**, Future Internet?: data units contain (almost) everything



Convergence Consortium and use cases (real world)

- MPEG Standardization (CEDEO sas di Chiariglione Leonardo)
- Applications (SINGULARLOGIC)
- Security (Smart Card, ABE based, MORPHO)

- Pictures (ALINARI)
- Videos (Fondation Maison des Sciences de l'Homme)
- Podcasts (Ludwig-Maximilians-Universitaet Muenchen)
- Real World Objects (UTI+WIPRO)
 - lifecycle management of VDI-enabled Real-World Objects in a large retailer/shopping mall
 - logistics, in store & on shelf management, warehousing

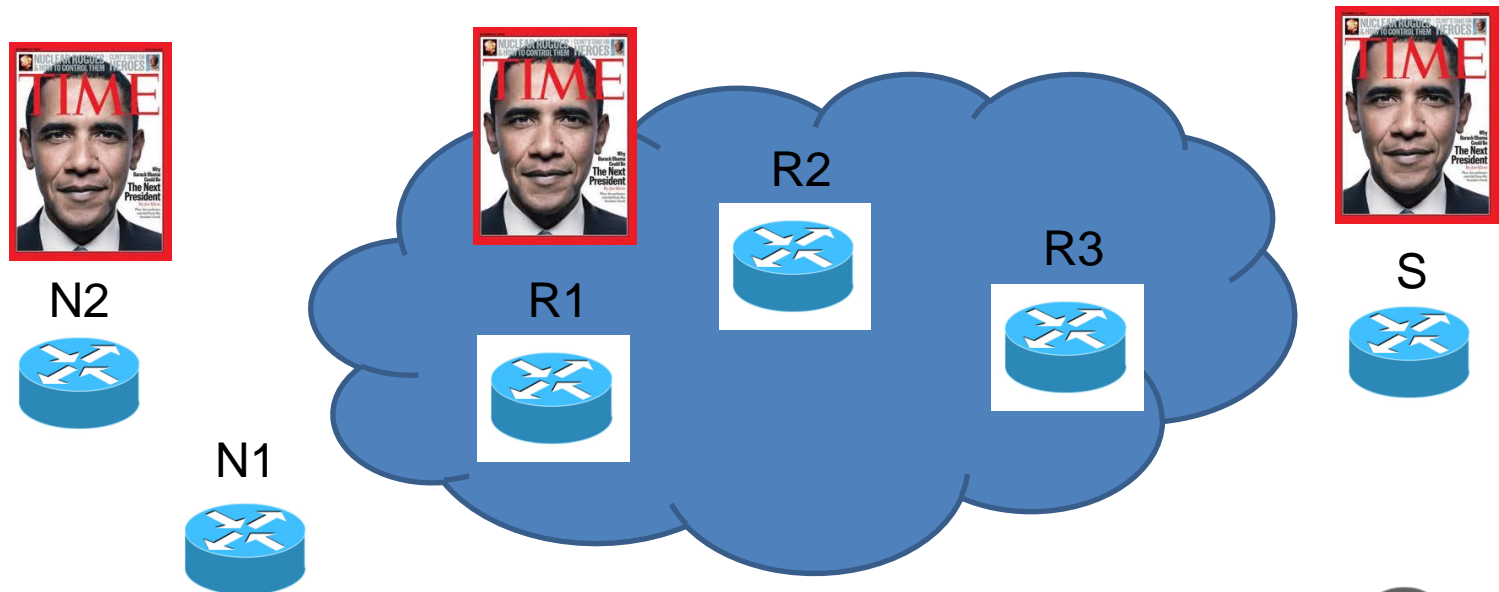
- Network experiments over OpenFlow-OFELIA
- Research

Standardization (ISO-MPEG and IETF/IRTF)

- Several contributions to MPEG:
 - <http://www.ict-convergence.eu/standardization/>
 1. “Preliminary input contribution for DID extension“
 2. “Proposal to extend MPEG-21 DII with means to support a semantically explicit declaration of relationships between Digital Items“
 3. “Proposal for reengineering of MPEG-M reference software“
 4. “The CONVERGENCE project – A bird’s eye view“
 5. “Proposal for improving MPEG-M base schema“
 6. “A demonstration of MPEG-M technologies in Convergence“
 7. “Input contribution on Overlay Technology“
 8. “First step towards unified orchestrator/aggregation environment“
 9. “Proposed PE/ES implementation of MPEG-M part3“
 10. “Amendment for DII Digital Item Semantic Relationships“
 11. “Introducing User Identification in MPEG-M“

Convergence Network (CONET)

- Basic functions:
 - **address contents**, adopting an addressing scheme based on names (identifiers), which do not include references to their location
 - **route** a user request toward the closest copy of the content with such a name (name-based anycast routing)
 - **deliver** back the content to the requesting host



Convergence Network (CONET)

- Additionally:
 - provide a native, **in-network caching** functionality
 - exploit **security information embedded** in the content
 - to avoid the diffusion of fake versions of contents
 - to protect the content, as opposed to exploit connection-based or application-based security; protecting information at the source is more flexible and robust than delegating this function to applications, or securing only the communications channels
 - provide a **per-content quality of service differentiation**; the network should offer differentiated performance to different contents/services

Advantages

- **Efficient content-routing**
 - Content Delivery Networks (CDNs) offer a similar functionality but they cannot use network resources in an optimal way because they operate over-the-top (and do not have information on other CDNs and on the network status)
- **In-network caching**
 - off-the-shelf HTTP transparent proxies require stateful operations
 - CDNs are for pros, they are not “democratic”
- **Support for peer-to-peer like communications**
 - without the need of overlay dedicated systems
- **Per-content quality of service differentiation**
 - without deep packet inspection technologies (especially over radio channels)

Advantages

- **Handling of mobile and point-to-multipoint communications**
 - simplifying handovers and stateful nodes
- **Content-oriented security model**
 - securing the content itself, instead of securing the communications channels
- **Support for time/space-decoupled communications**
 - providing publish/subscribe and allowing “pieces” of network or single devices to operate even when disconnected from the main Internet (e.g. sensors, ad-hoc, delay-tolerant-networks, social gatherings, vehicle, trains, planes, cars)
 - “stop the Internet from crashing”
 - balancing the power: Over the Top players (Skype, Facebook) vs. Network Operators

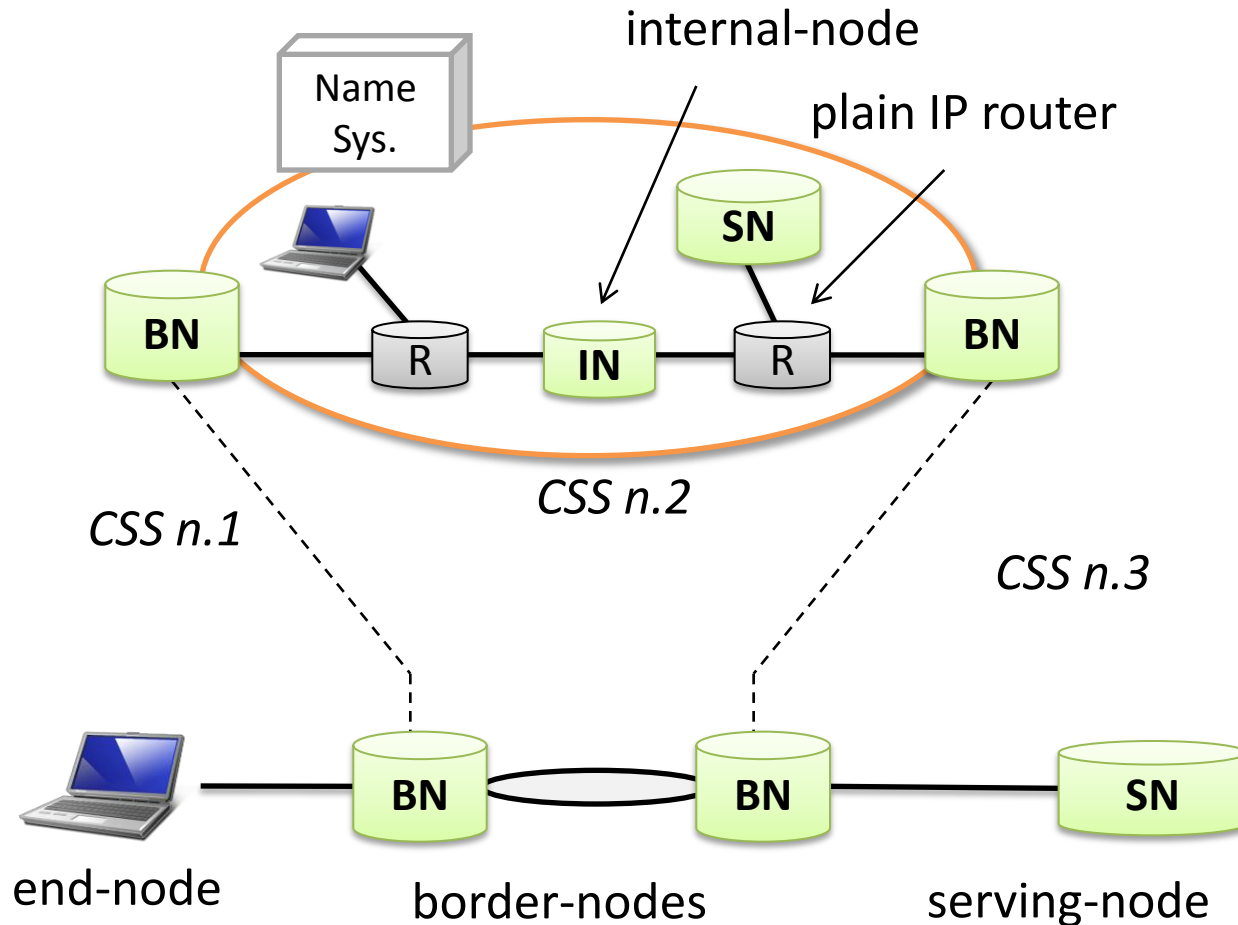
Disadvantages

- **Changes** in the basic network operation
- **Scalability** concerns
 - the number of different contents and corresponding names is much bigger than the number of host addresses (size of routing tables and complexity of lookup functions)
 - guaranteeing bidirectional communication (reverse paths) requires maintaining states in network nodes
- **Cumbersome support** for “conversational” communication pattern

TO DO list

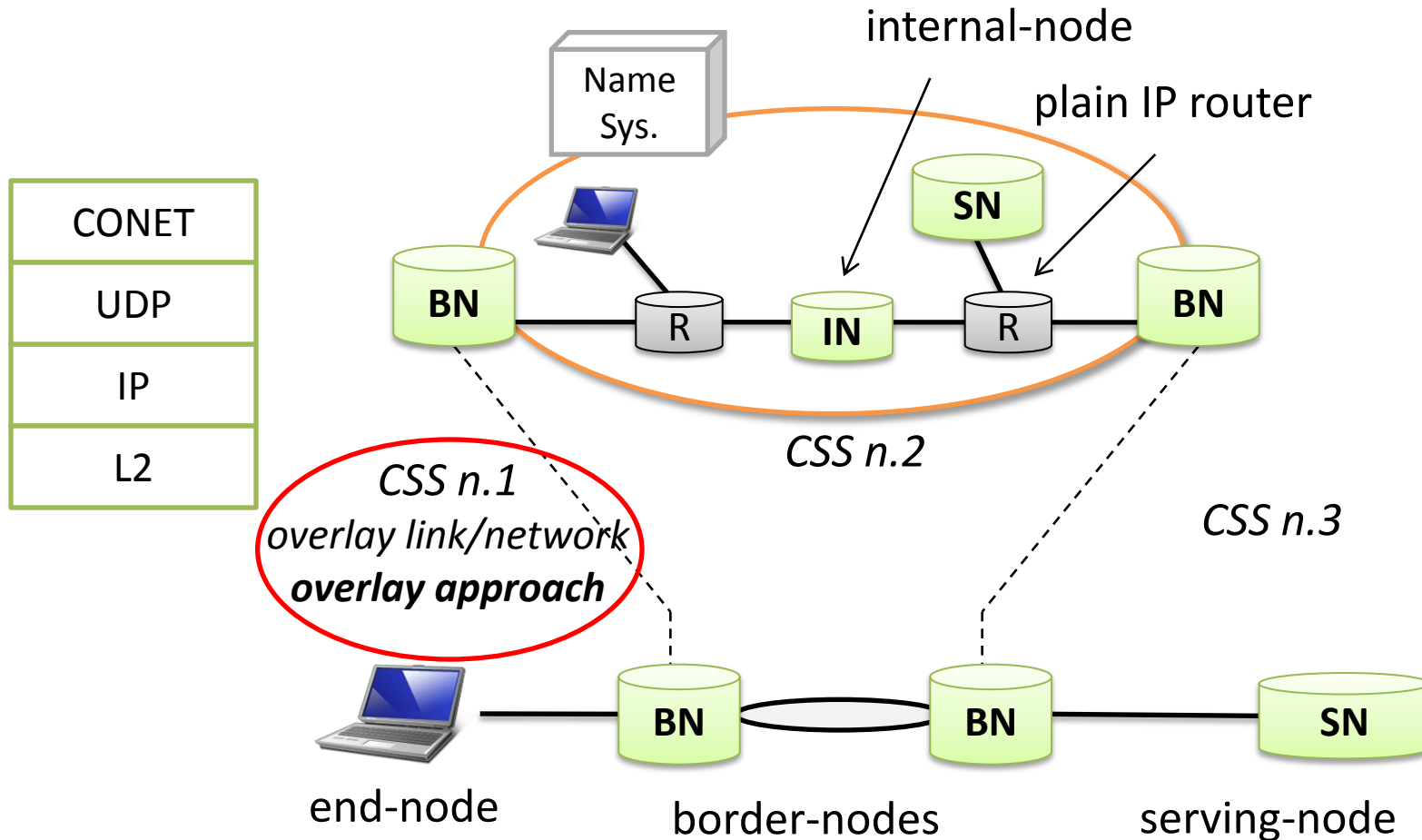
- Naming
- Forward-by-name
- Content routing
- Data forwarding
- Caching
- Segmentation & transport
- Security

Network architecture



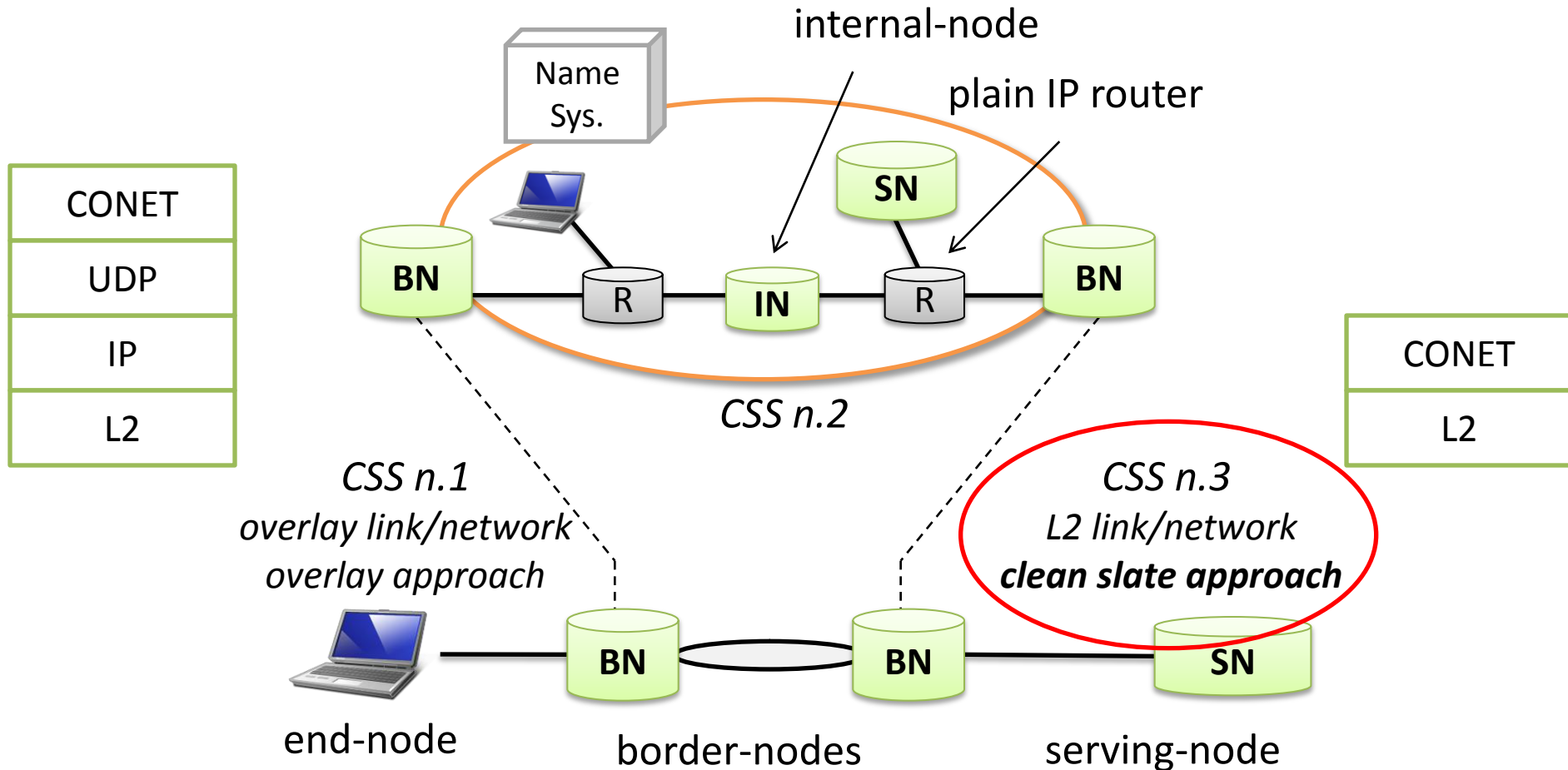
- CONET nodes interconnected by CONET Subsystems (CSS)

Network architecture



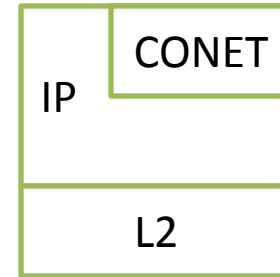
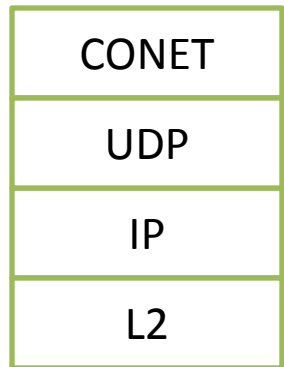
- CONET nodes interconnected by CONET Subsystems (CSS)

Network architecture

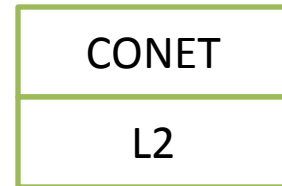
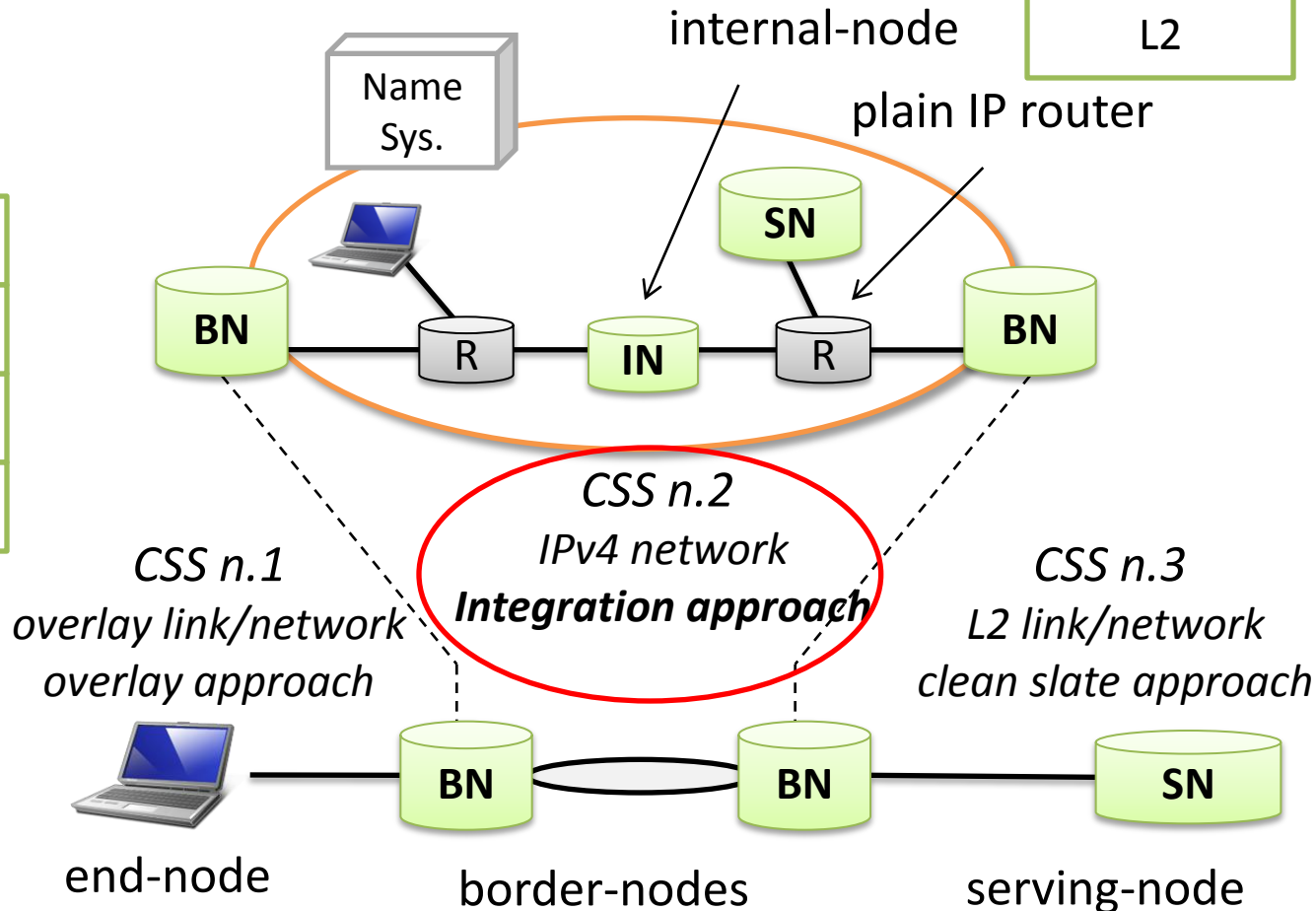


- CONET nodes interconnected by CONET Subsystems (CSS)

Network architecture

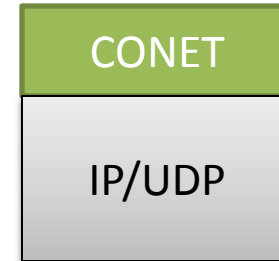


IP CONET
Option



- CONET nodes interconnected by CONET Subsystems (CSS)

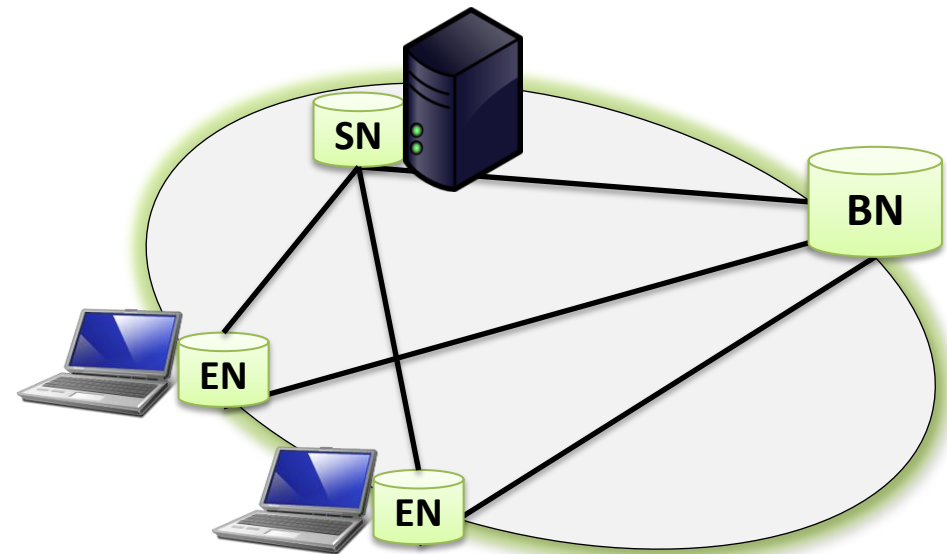
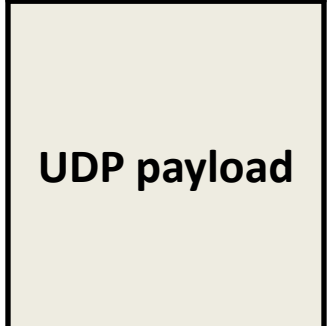
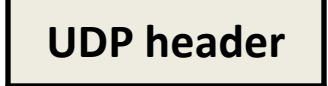
CSS deployment: overlay



carrier-packet



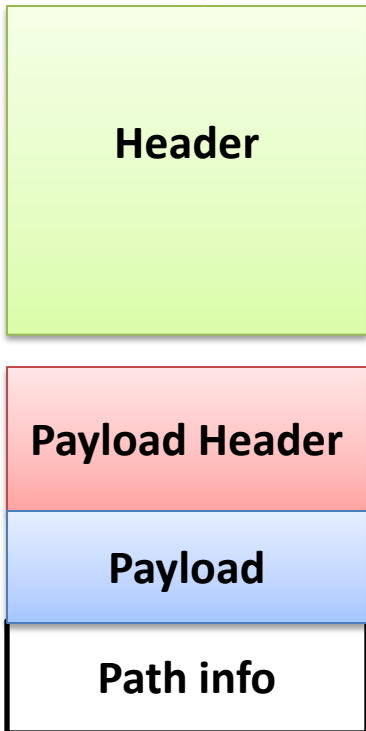
UDP/IP packet



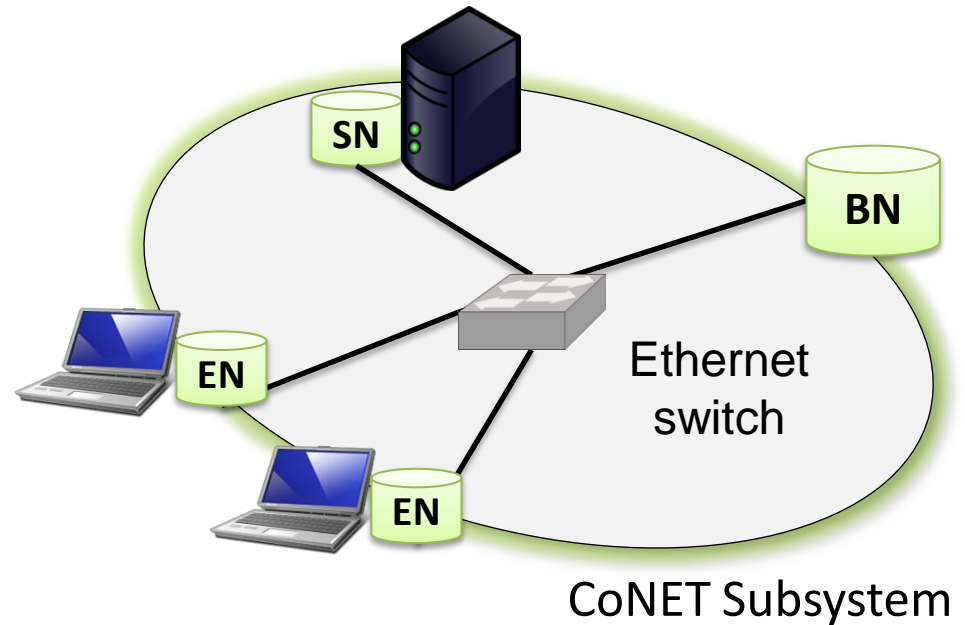
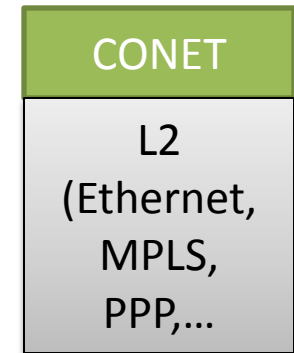
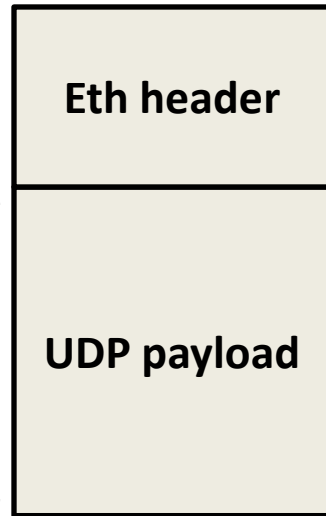
CoNET Subsystem

CSS deployment: clean-slate

carrier-packet



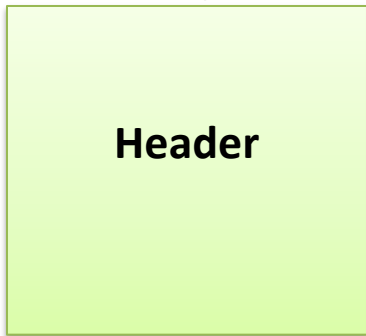
Eth frame



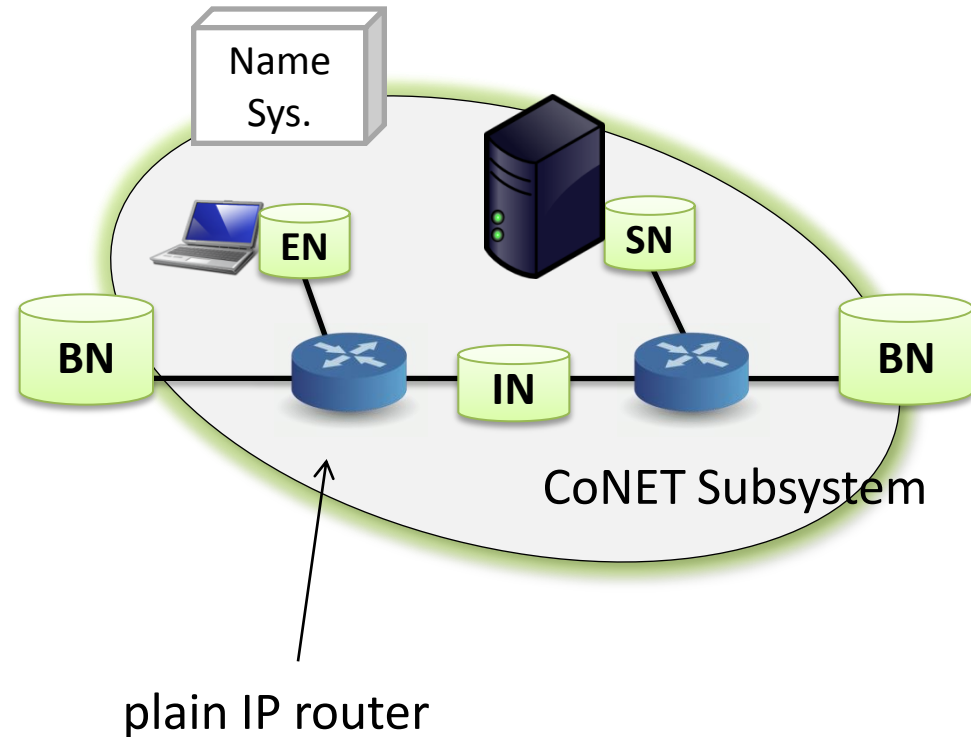
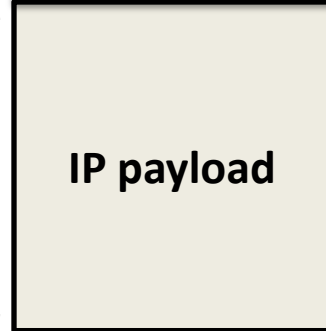
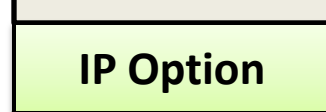
CSS deployment: integration



carrier-packet



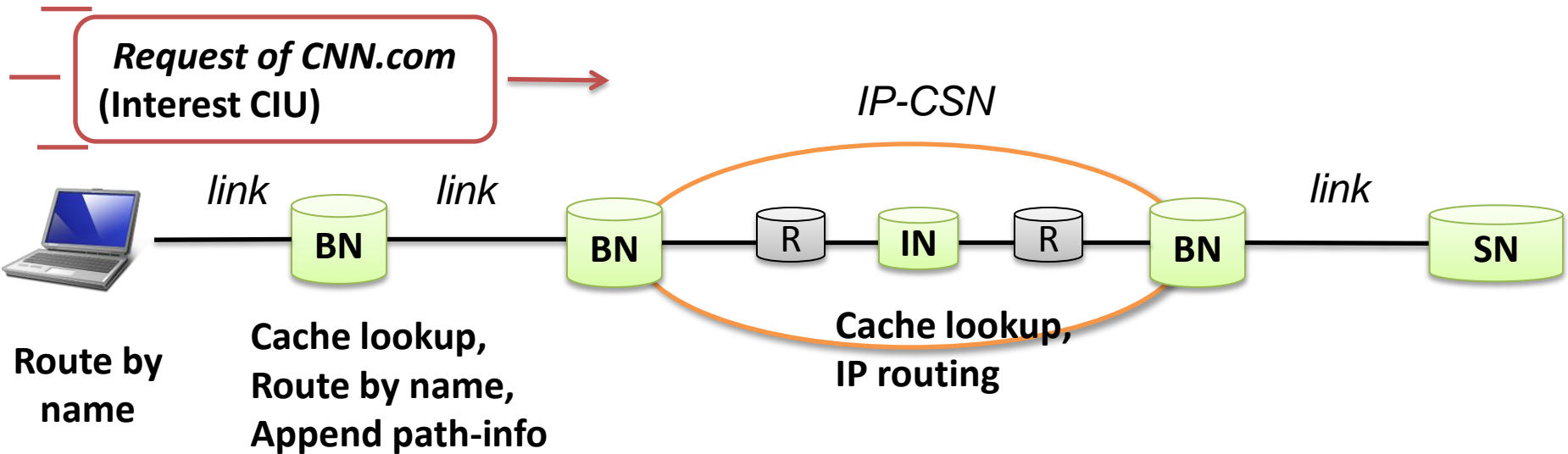
UDP/IP packet



CONET Subsystems (CSS)

- CONET protocols implemented only in user equipments
 - only one CSS: the current Internet
- CONET protocols implemented in current border gateways (i.e. where BGP runs)
 - CSSs coincide with current Autonomous Systems
- CONET protocols implemented in all current routers
 - CSSs coincide with current IP subnets
- CONET protocols implemented in nodes that interconnect different layer 2 networks, removing IP
 - CSSs coincide with such layer 2 networks

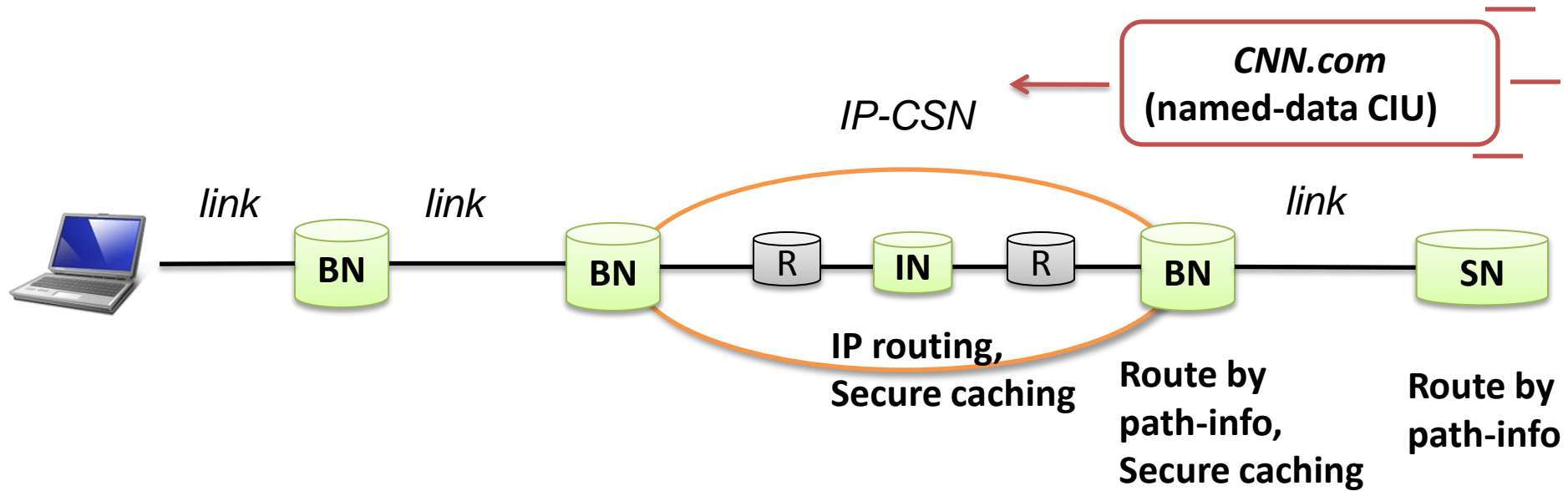
Mode of operation (upward)



Name-based routing table

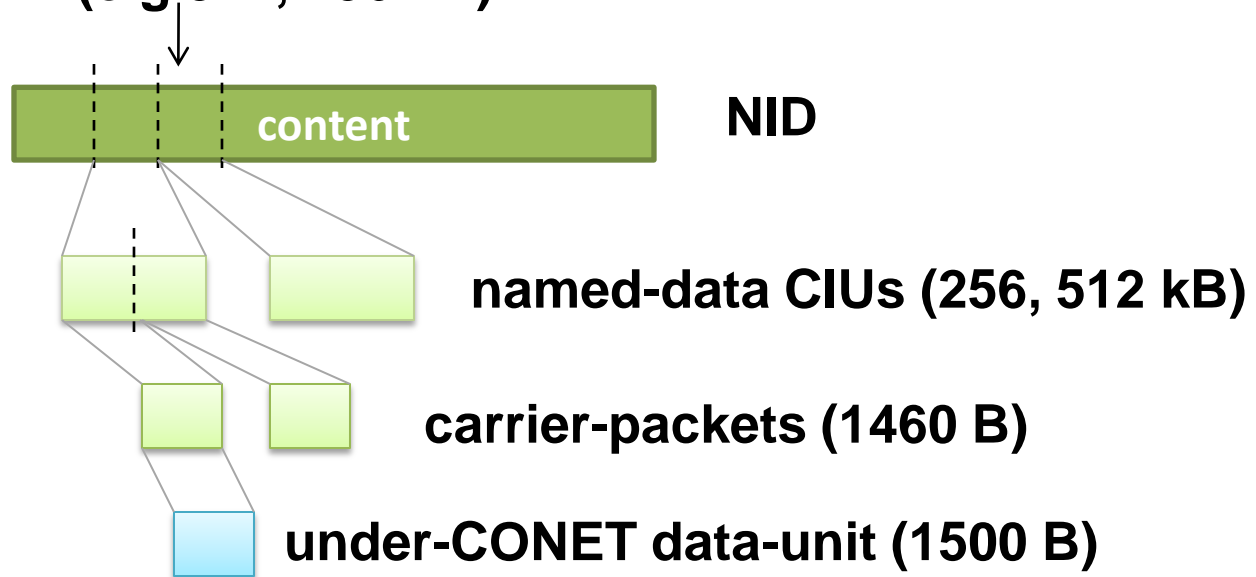
Name	Mask	Next Hop Address	Interface	Metric
www.cnn.com	ff.ff.ff/0	00:18:84:1f:d5:99	Eth0	1
www.yuotube.com	ff.ff.ff/0	160.80.80.1	IPO	1
mail.google.com	ff.ff.ff/0	172.34.6.19	tun0	1

Mode of operation (downward)



Fragmentation

Chunk (e.g 512, 256 kB)



Border and Internal Node architecture

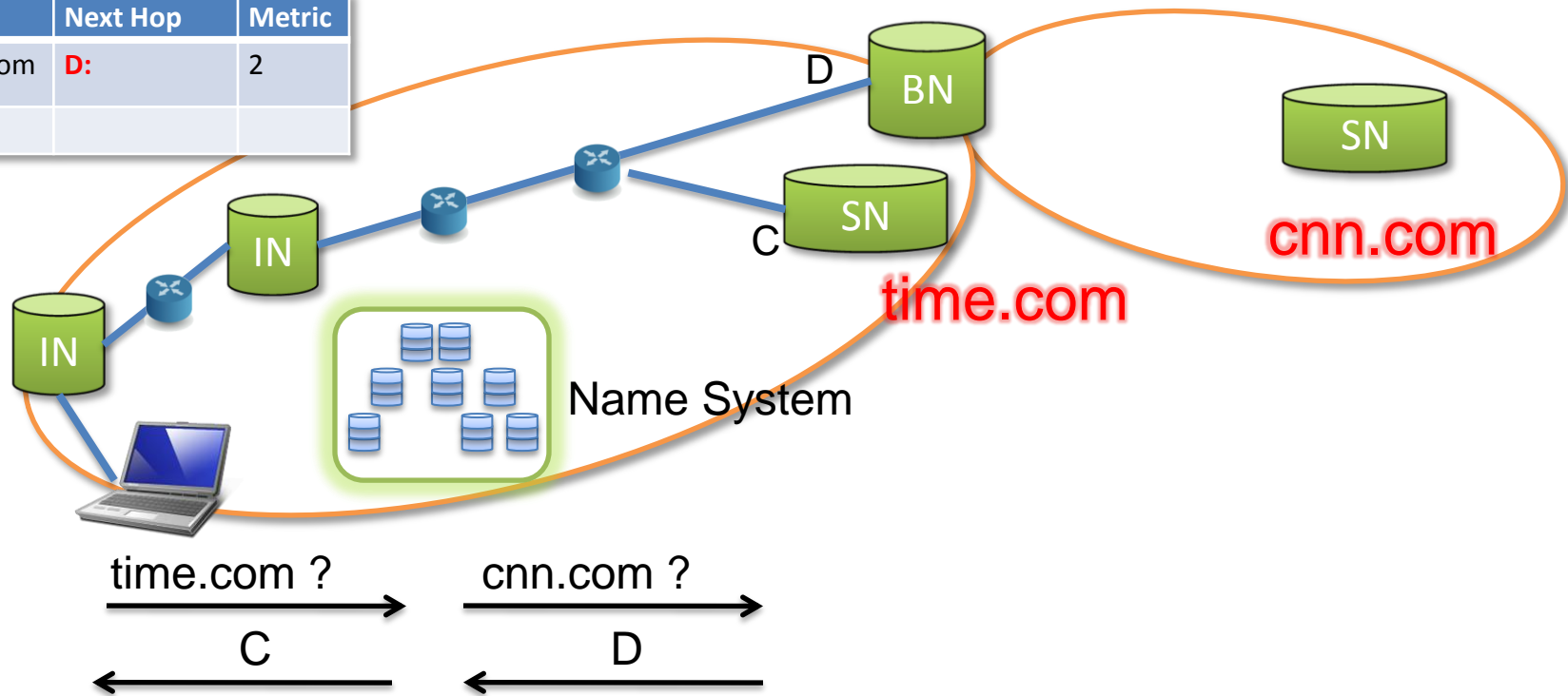
Hybrid Forwarding Table IP routes, name-based routes, cached content

Name or Network	Mask	Chunk Number	Next Hop Address	Interface	Metric
160.80.80.0	/16	*	160.80.80.1	eth0	1
www.yuotube.com	ff.ff/0		74.125.95.93	IP-CSN0	1
www.myspace.com/photo1.jpg	ff.ff.ff/ff.ff	1	Local cache	local	0



Lookup and cache

- Routing table handled as a cache
- In case of a missing routing entry, a Name System provides the entry, which is temporary stored in the table
- Name System also handles best replica selection

Name	Next Hop	Metric
time.com	D:	2



Experimentation over OFELIA: Background

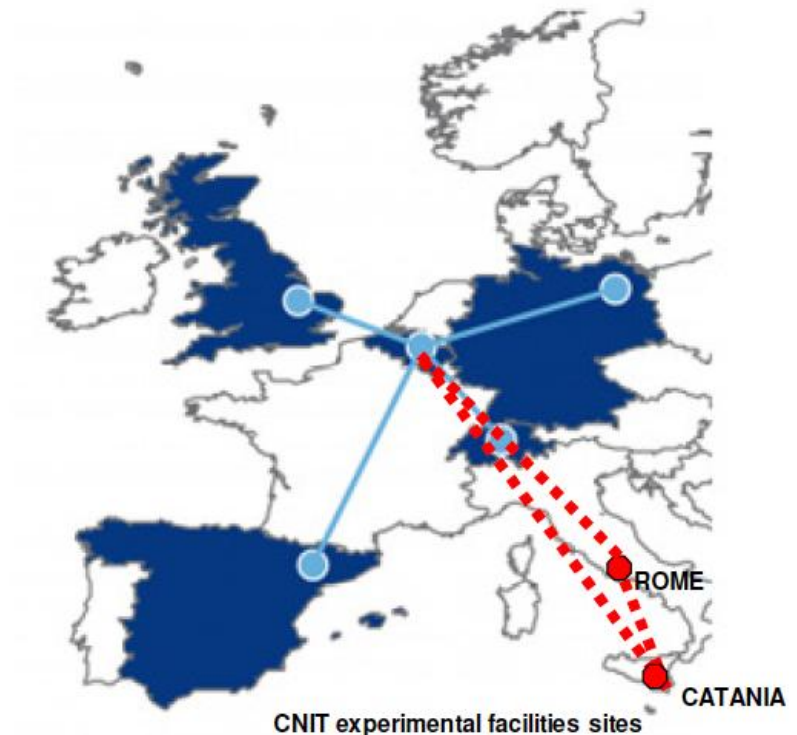
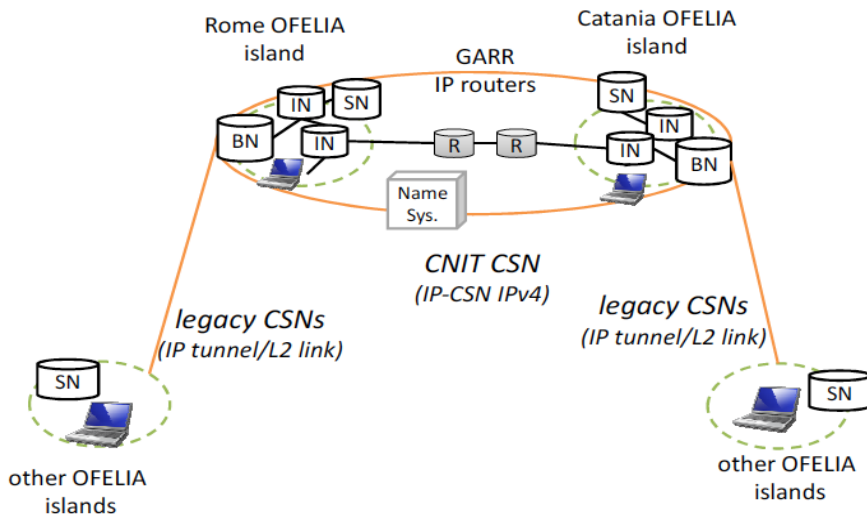
-  is an *open standard* enabling experimentation of new protocols in current networks:
 - It envisages a *switch* (for **switching** operations) and a *controller* (for **higher layer** operations)
 - It is a feature of commercial Ethernet switches, routers and wireless access points
 - It provides *standardized hooks* → researchers can run experiments, without accessing internal workings of network devices
-  is a *FIRE project* that is setting up a large experimental facility based on OpenFlow

CONVERGENCE and OFELIA

- CONVERGENCE will run experiments over the OFELIA experimental facility
 - CONET functionality
 - Convergence “real world” trials
- CNIT (coordinator of CONVERGENCE) has won an open call to become partner of OFELIA
 - ... extension of OpenFlow in terms of controller architecture and of the OpenFlow interface itself, towards ICN support
 - ...reference implementation in a switch based on Open vSwitch, and in a NetFPGA-based OpenFlow switch
 - Fast forwarding can be implemented by the OpenFlow switch
 - Caching and other complex functionality can be performed by the controller

Integration with the OFELIA facility

- Rome and Catania islands with 1Gbps connections with GARR (the Italian national research & education network):
 - It is integrated with the GEANT
 - It is interconnected to several commercial networks



Thank you for your attention

Questions?



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The future

- Separation of user and control plane
 - “Extensibility: functionality w/ backwards compatibility
 - Deploy functionality in parallel, let apps/stacks choose
 - Modularity: no implementation details in interfaces
 - Only expose necessary semantics”

by Scott Shenker, University of California at Berkeley

The Consortium

1. CNIT (I) (Co-ordinator) www.cnit.it  consorzio nazionale
interuniversitario
per le telecomunicazioni

2. ALINARI 24 ORE (I) www.alinari.com



3. CEDEO sas di Chiariglione Leonardo (I) www.cedeo.net



4. FONDATION MAISON DES SCIENCES DE L'HOMME (FR)
www.msh-paris.fr.it



5. ICCS of National Technical Univ. of Athens (GR) www.ntua.gr

6. INSTITUTO DE ENGENHARIA DE SISTEMAS E COMPUTADORES DO PORTO (PT)
www.inescporto.pt



7. LUDWIG-MAXIMILIANS-UNIVERSITAET MUENCHEN (D)
www.uni-muenchen.de



8. MORPHO (D) www.morpho-edocs.com



9. SINGULARLOGIC (GR) www.singularlogic.eu



10. UTI (RO) www.uti.ro



11. WIPRO (PT) www.wipro.com



12. XiWrite s.r.l. (I) www.xiwrite.com

