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A FIRE Project

The nvergence 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**


Functionality

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

Alternatives

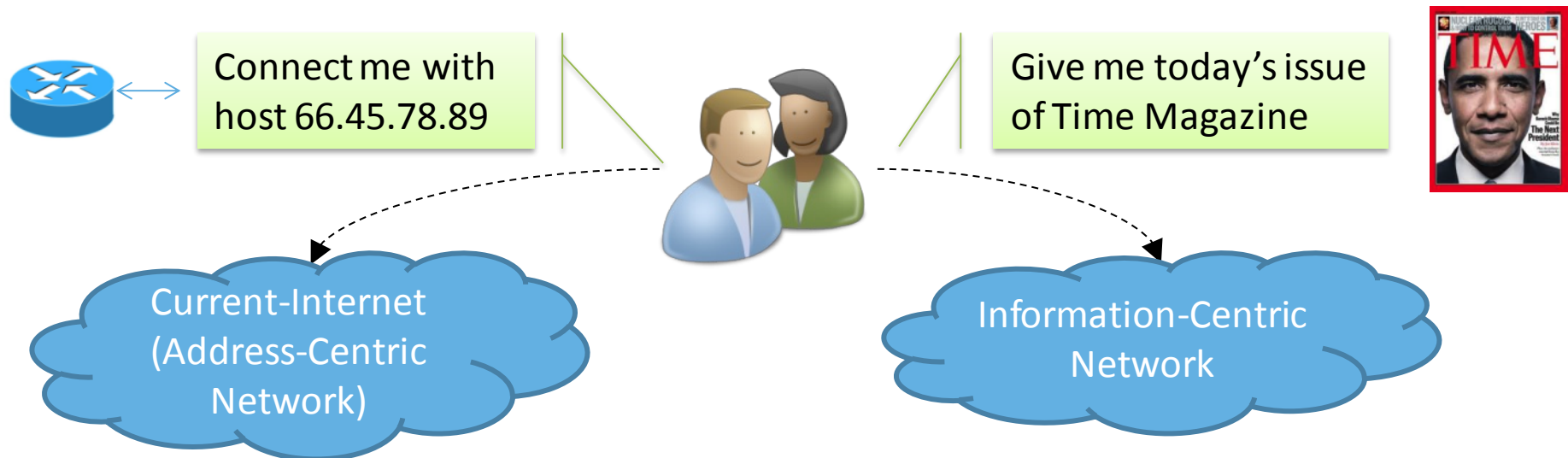
1. Different Application-layer data units (specific, proprietary)
2. Applications (specific, proprietary)
3. Current Internet

or

- 
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)

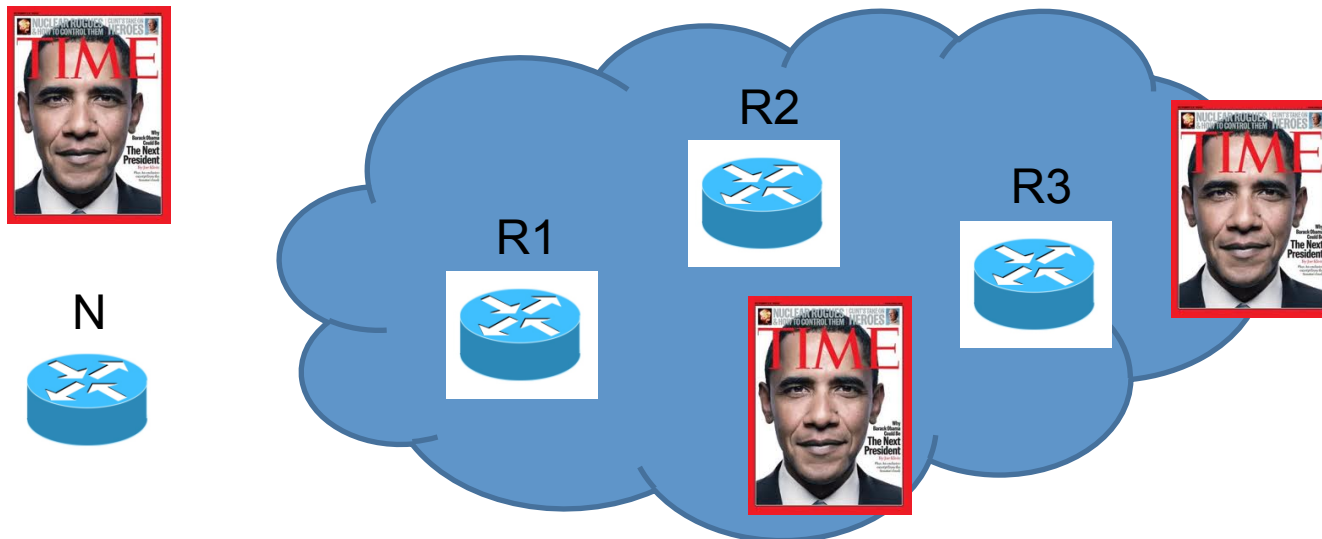
Information Centric Network

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



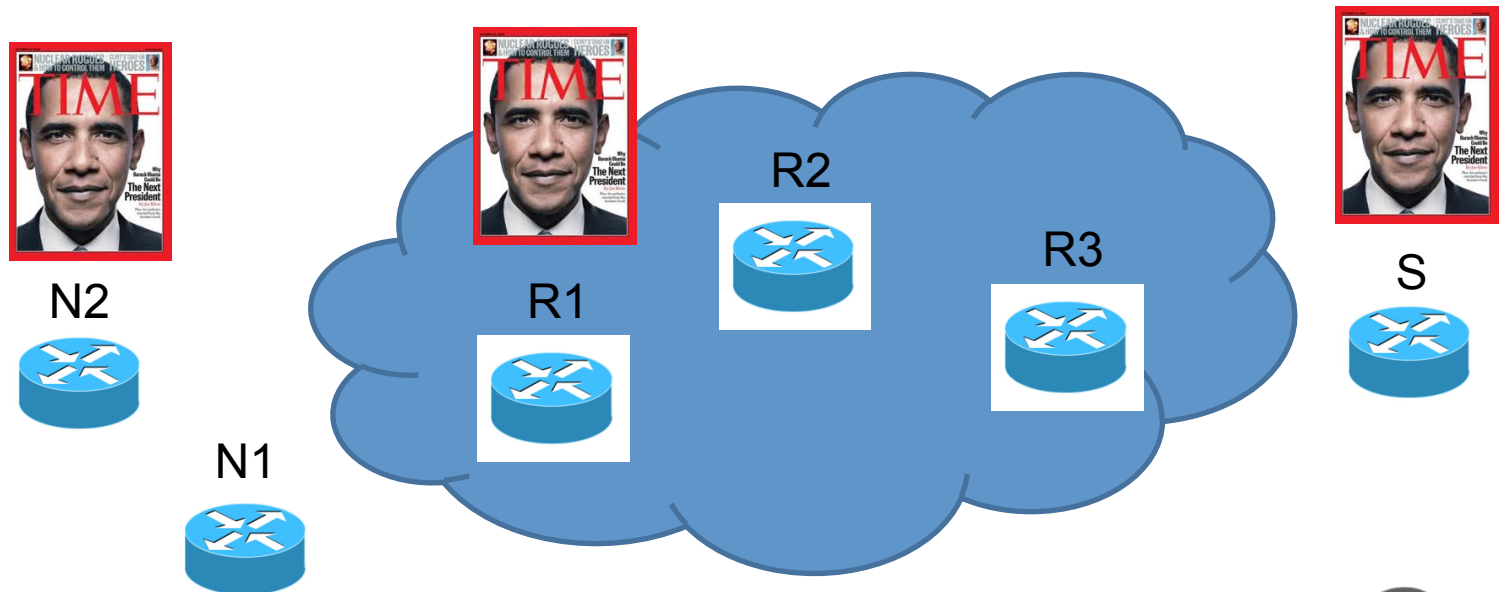
Shift of paradigms

- 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 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



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 or using source routing
- **Cumbersome support** for “conversational” communication patterns

TO DO list

1. Primitives & interfaces
2. The naming scheme
 - it specifies the identifiers for the contents addressed by ICN (usability, scalability and security)
3. The forward-by-name (or route-by-name) mechanism
 - it relays an incoming content request to an output interface (“name-based” forwarding table)
4. The routing protocols
 - used to disseminate information about location of contents, so as to properly setup the name-based forwarding tables
5. The data forwarding mechanism
 - it sends the content back to the device that issued a content request
 - it cannot use the forward-by-name mechanisms, because, typically, devices/interfaces are not addressed by the content routing plane

TO DO list

6. In-network caching

- caching data and replying to incoming content requests

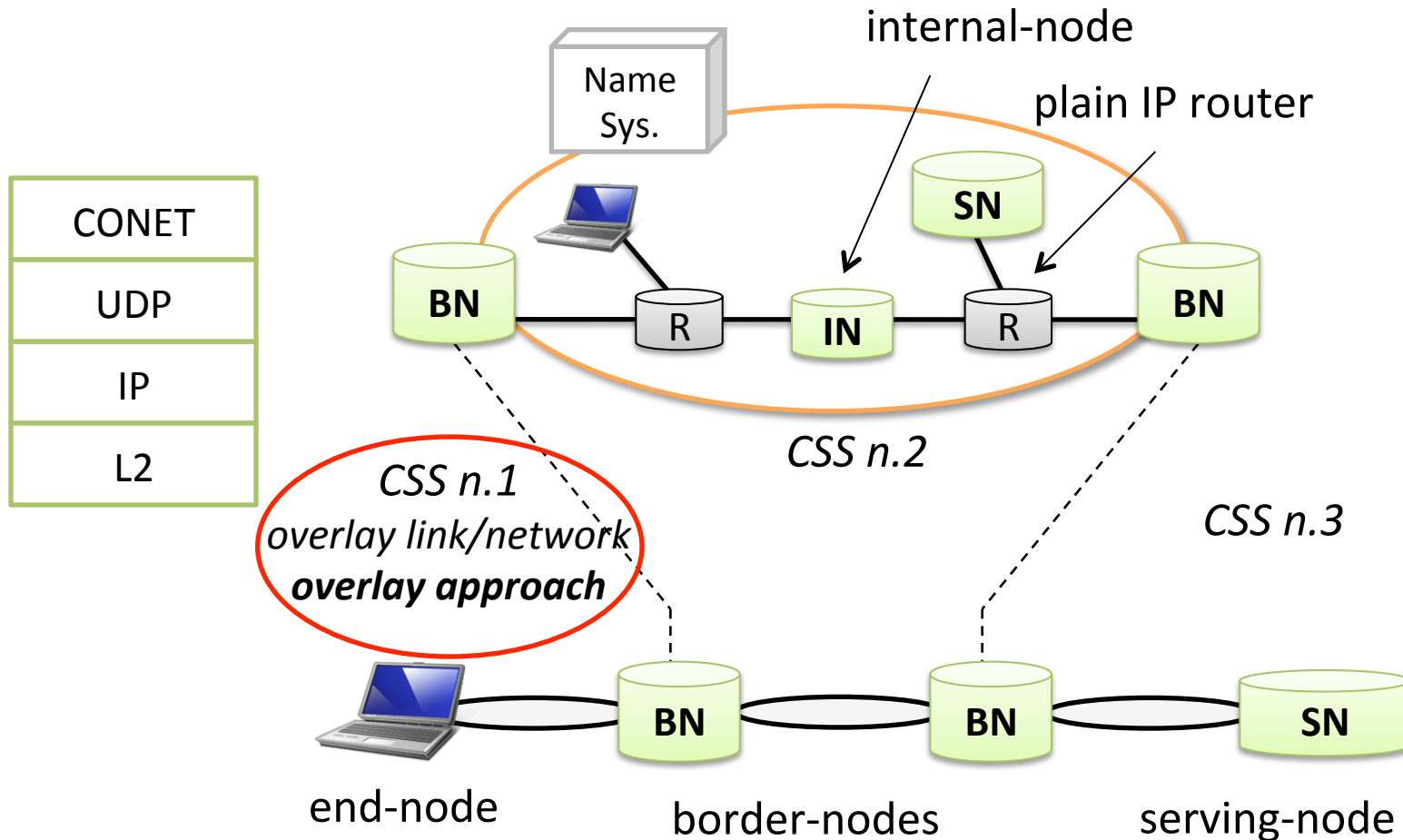
7. Segmentation & transport mechanisms

- splitting a content in different chunks
- reliable transfer and congestion control

8. Security & privacy issues

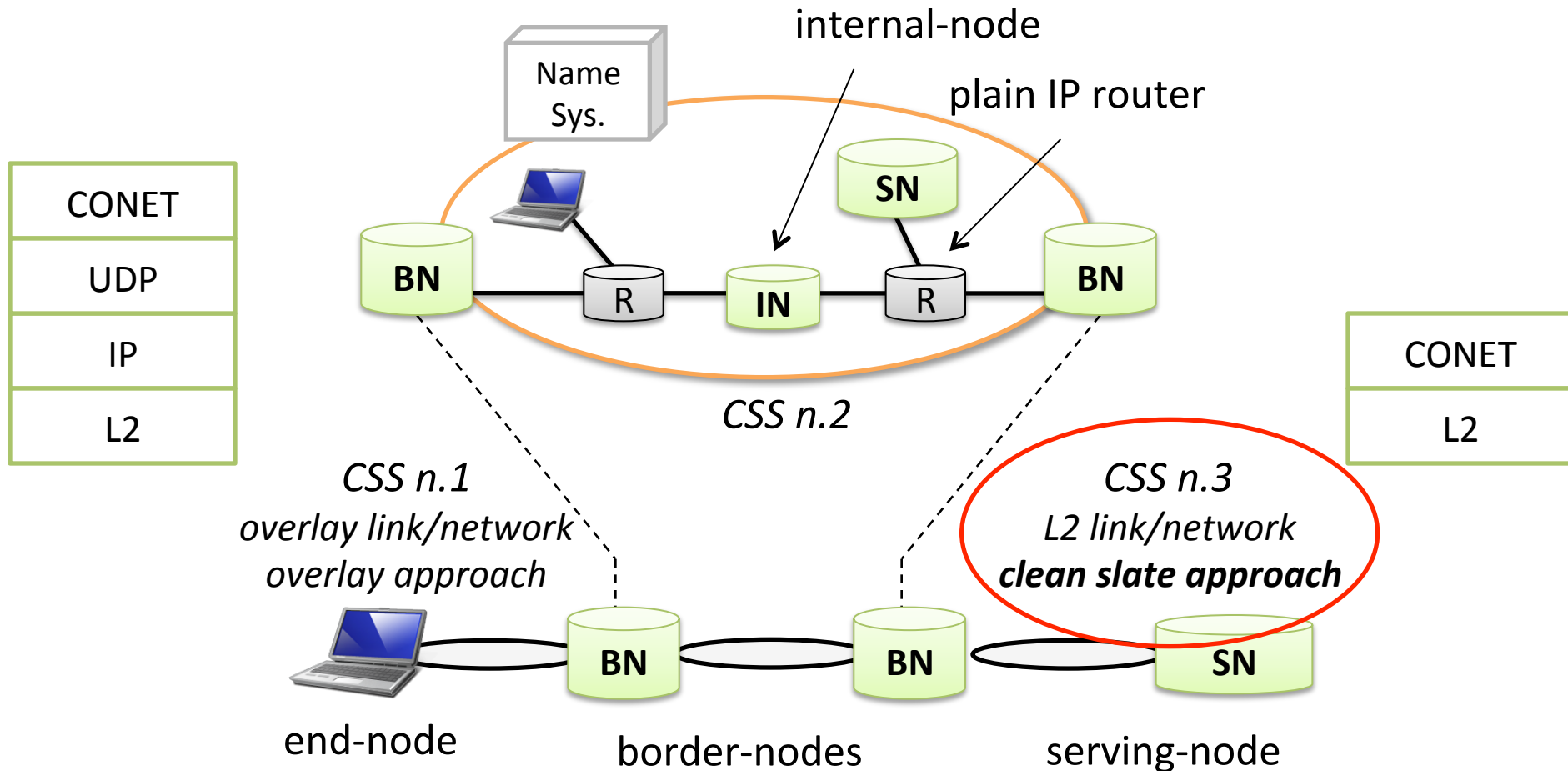
- providing content authenticity, protecting the network from fake content, which could also pollute network caches
- guaranteeing that content be accessed only by intended end users
- protecting information consumers from profiling or censorship of their requests

Network architecture



- CONET nodes interconnected by CONET Subsystems (CSS)

Network architecture



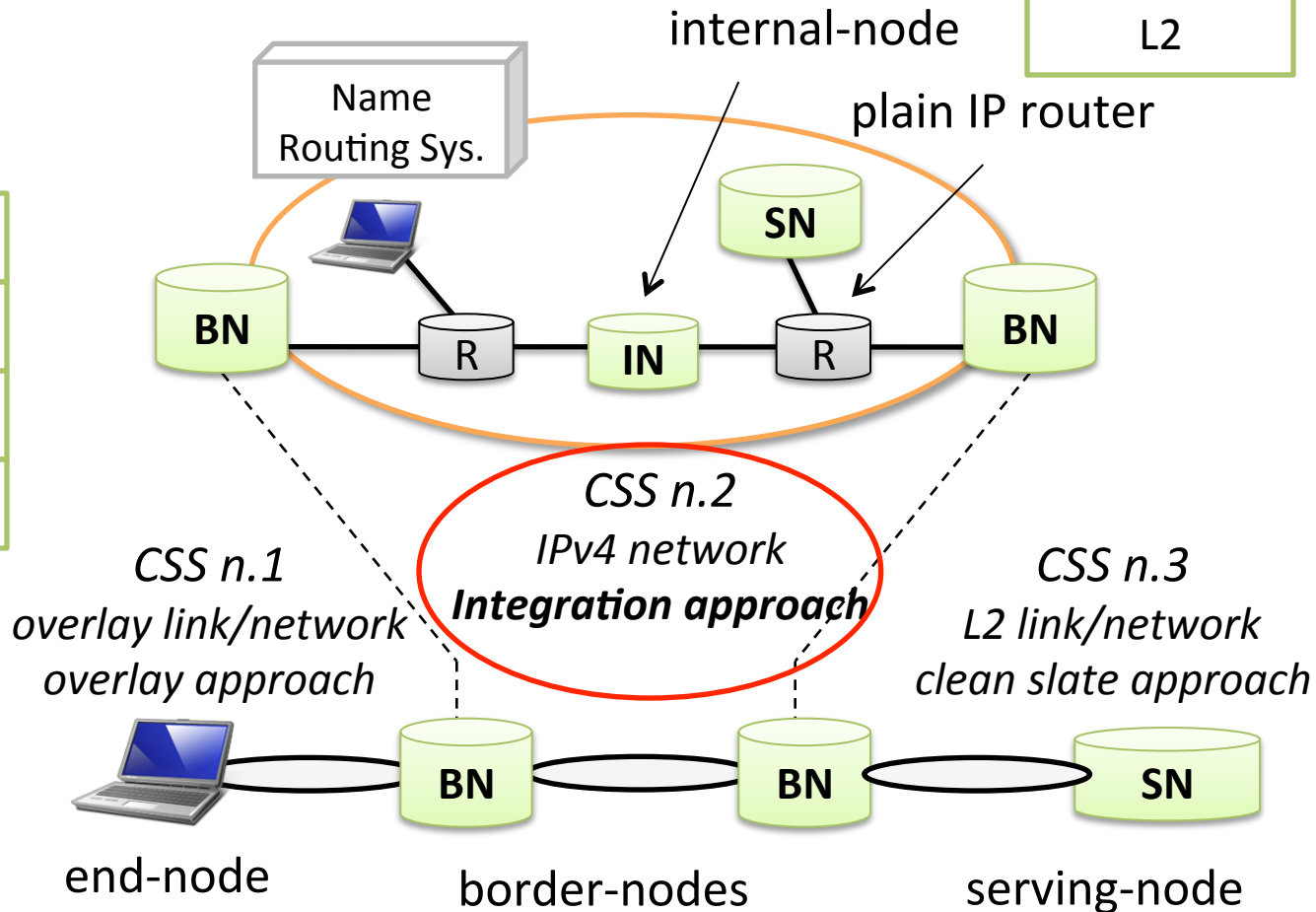
- CONET nodes interconnected by CONET Subsystems (CSS)

Network architecture

CONET
UDP
IP
L2

IP	CONET
L2	

IP CONET
Option



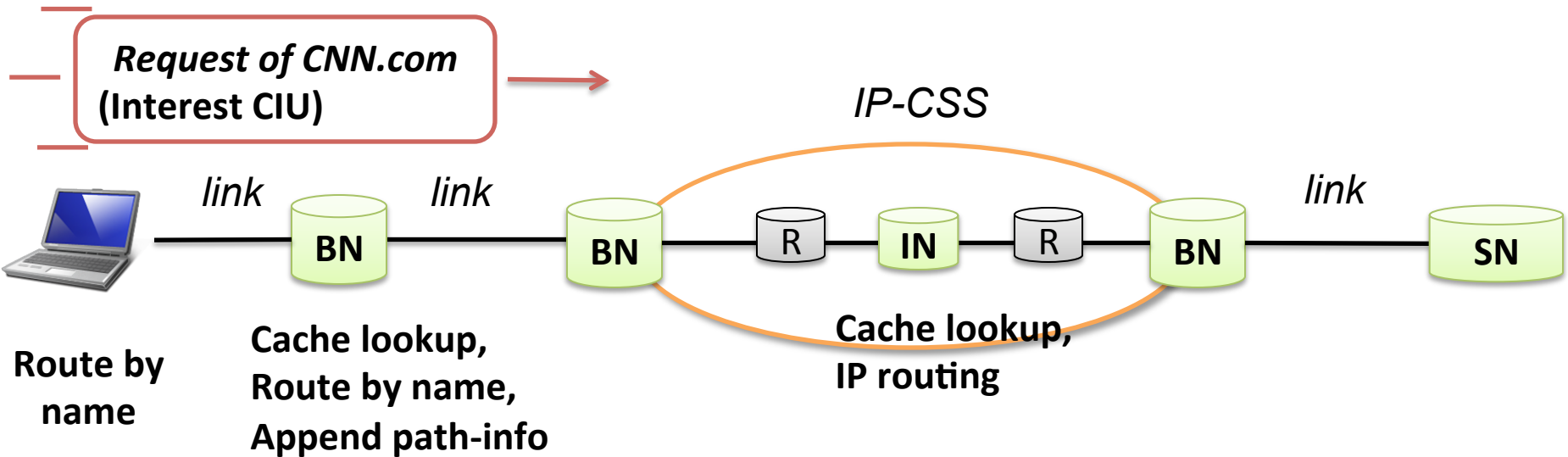
CONET
L2

- CONET nodes interconnected by CONET Subsystems (CSS)

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

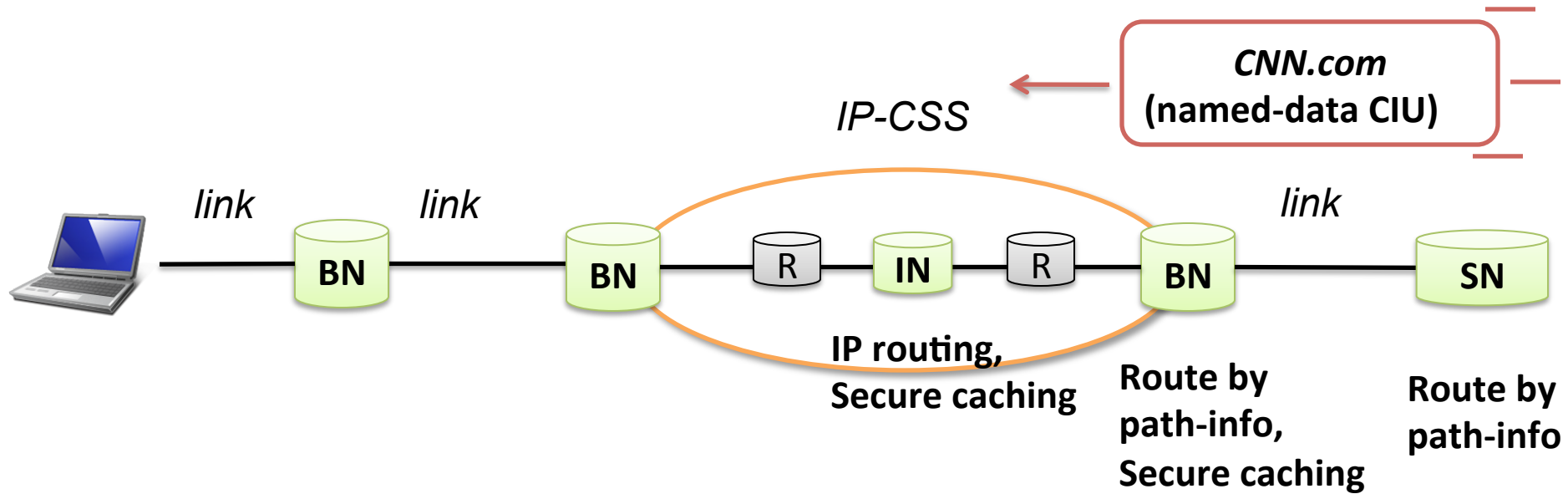
Mode of operation (upward)



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.youtube.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)



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.youtube.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

Measurements, applications

- Convergence applications and trials
 1. Professional photography, making it easier for photographers to contribute and describe photos, improving access for users and facilitating management
 2. Audiovisual archives, exploiting semantic techniques, when the same video resources are used in different contexts
 3. Podcasts with synchronized slides, which are annotated by students in a social learning environment
 4. Retailing supply chain for electronic products; lifecycle management of VDI-enabled Real-World Objects in a large retailer/shopping mall; logistics, in store & on shelf management, warehousing

Measurements, middleware

- Publish/Subscribe
- Search (semantic)
- Security mechanisms

Measurements, network

- Scalability
 - Routing
 - Naming
- Caching performance
 - Efficiency
 - Hit ratio
- Native peer-to-peer support
- Native mobility support
- Quality of service differentiation
- Video streaming on ICN
 - Quality of experience
 - Network usage

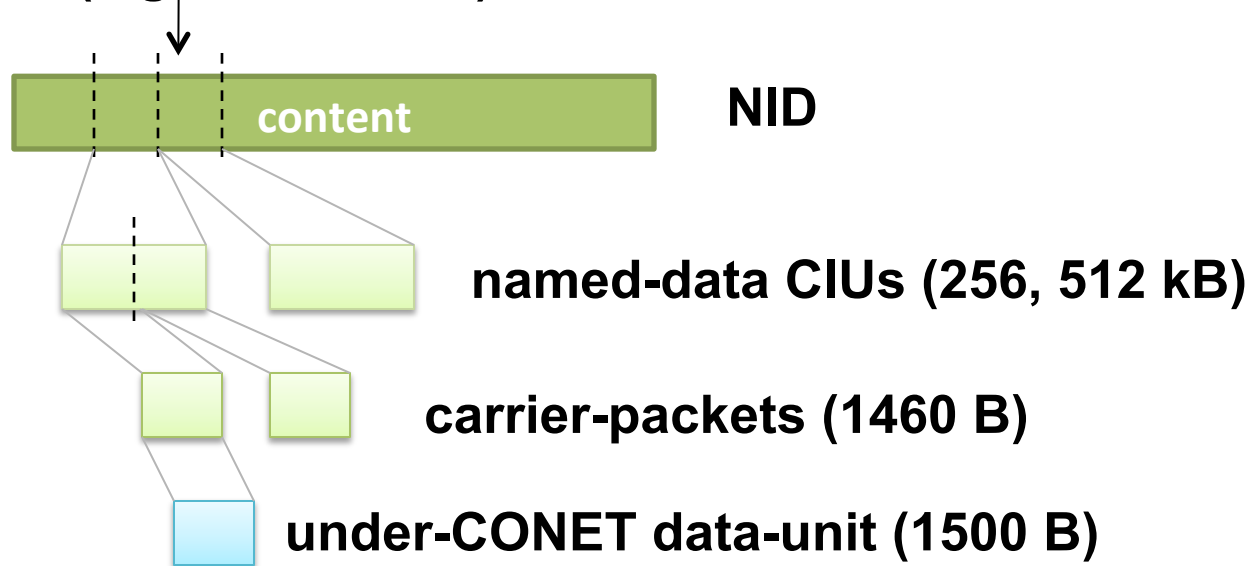
Measurements, design

- Examples
 - Relationship between number of IP addresses and number of host names

Measurements, design

- Fragmentation

Chunk (e.g 512, 256 kB)



Thank you for your attention

Questions?



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abstract

- This talk first introduces Information-Centric Networking (ICN), a new paradigm in which the network layer provides users with contents, instead of providing communication channels between hosts, and is aware of content identifiers.
- Then it presents the needs on measurements required by this approach in general and by the project CONVERGENCE in particular.
- ICN is significantly different with respect to the current networking architecture, and poses several new requirements to measurements, which have to be performed both in the current network (to understand some of its aspects useful for the design of ICN) and possibly in the new one.