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inbaverSim: An OMNeT++ Model Framework for Content Centric Networking

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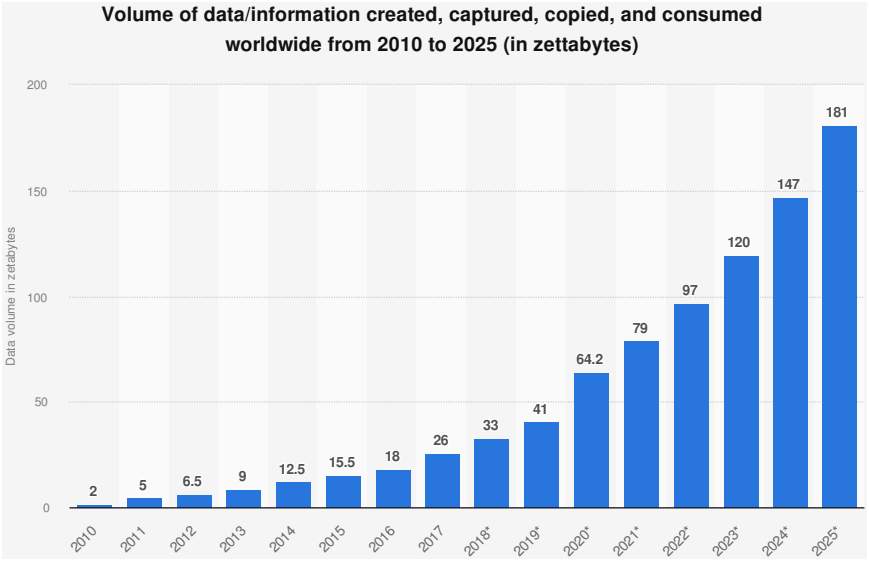
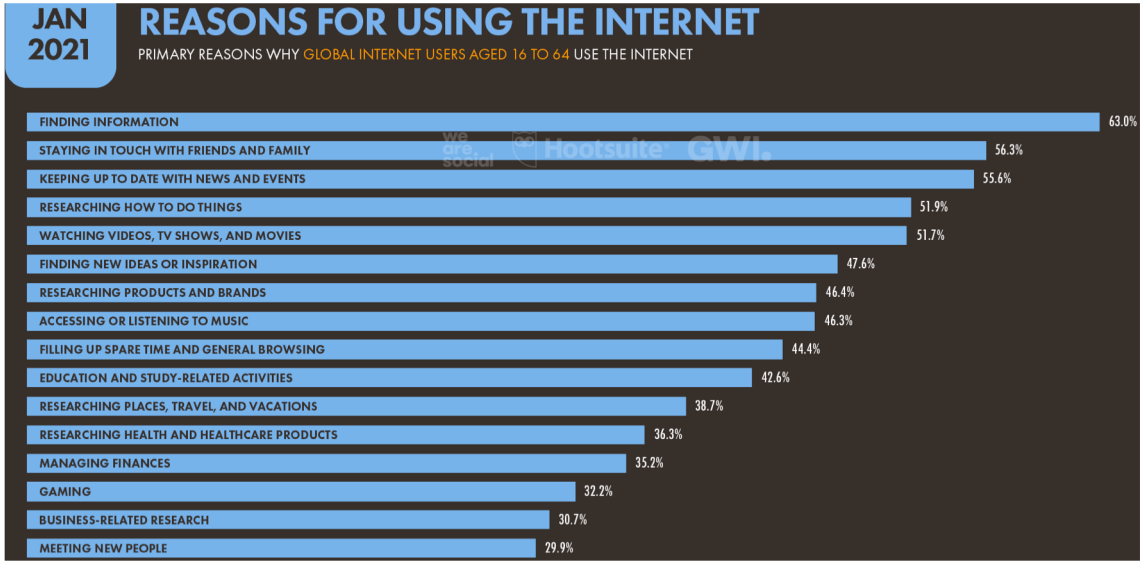
Motivation

Content Oriented Communications



Source: International Data Corp. (IDC), Seagate, Statista - 2021



Source: Global Web Index (GWI), Hootsuite - 2021

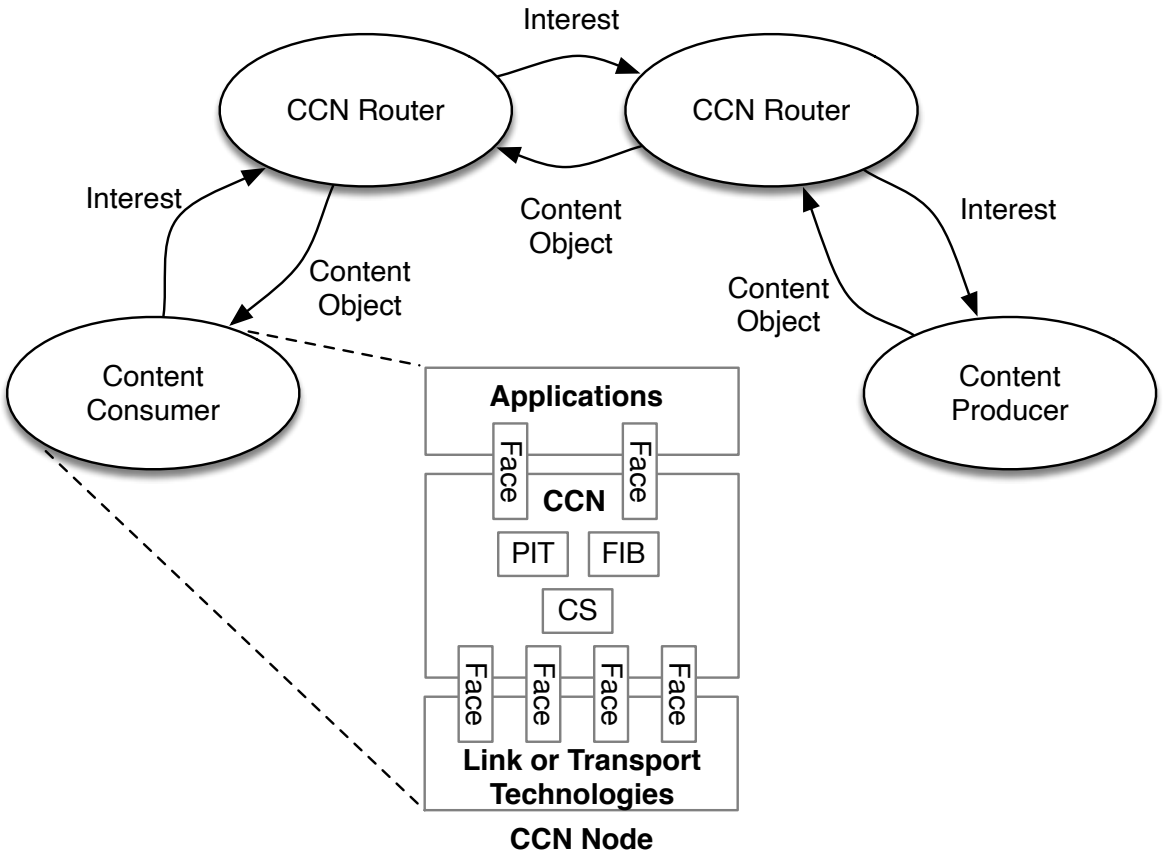
- Content generated has increased over time
- Most communications relate to retrieving information
- Majority use is moving content
- Solution – use of Information Centric Networks (ICN)

Necessity of CCN Model Framework

- Importance of Information Centric Networks (ICN)
  - Many architectures
  - IETF involvement (ICNRG)
  - Many standards, proposed standards
- Accepted architecture – Content Centric Networking (CCN)
  - Named Data Networking (NDN) is a derivative CCN
- Why a model framework?
  - 2019 IETF standardized CCN
  - 2 experimental RFCs – RFC8569, RFC8609

Content Centric Networking (CCN)

Architecture



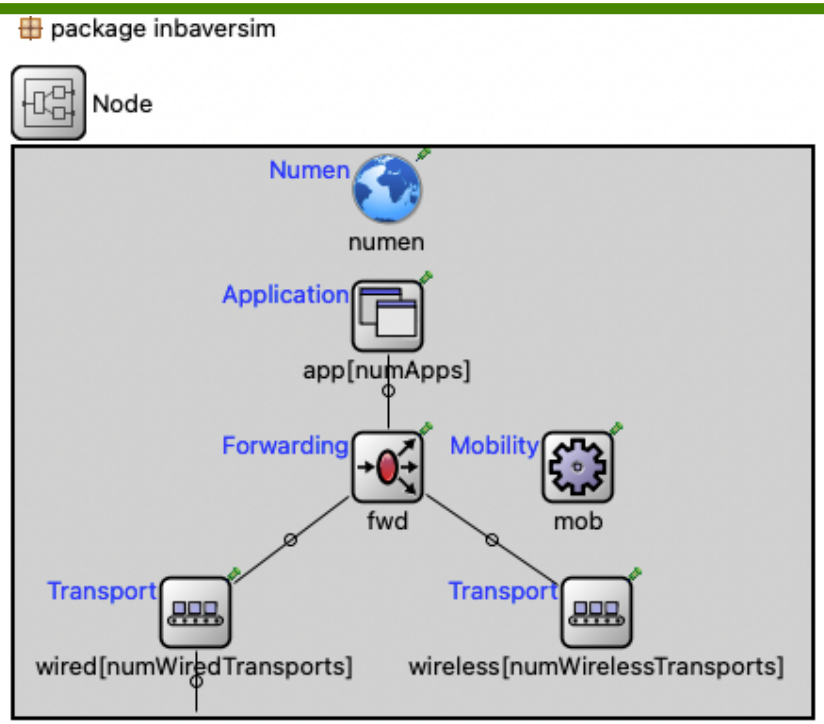
- Focus of CCN
  - Named hosts to named content (clean slate solution)
  - Focused on caching and forwarding secure content

Operations

- Basic information
  - Data pull type architecture – Request & response
  - Interest & Content Object
- Forwarding
  - Pending Interest Table (PIT) keeps pending requests
  - Forwarding Information Base (FIB) lists where to forward requests
  - Content Store (CS) stores received content
  - Faces are interfaces (link technologies or applications)
- Link
  - Can overlay any transport technology or link technology

Model Framework

Node Architecture and Layer Models

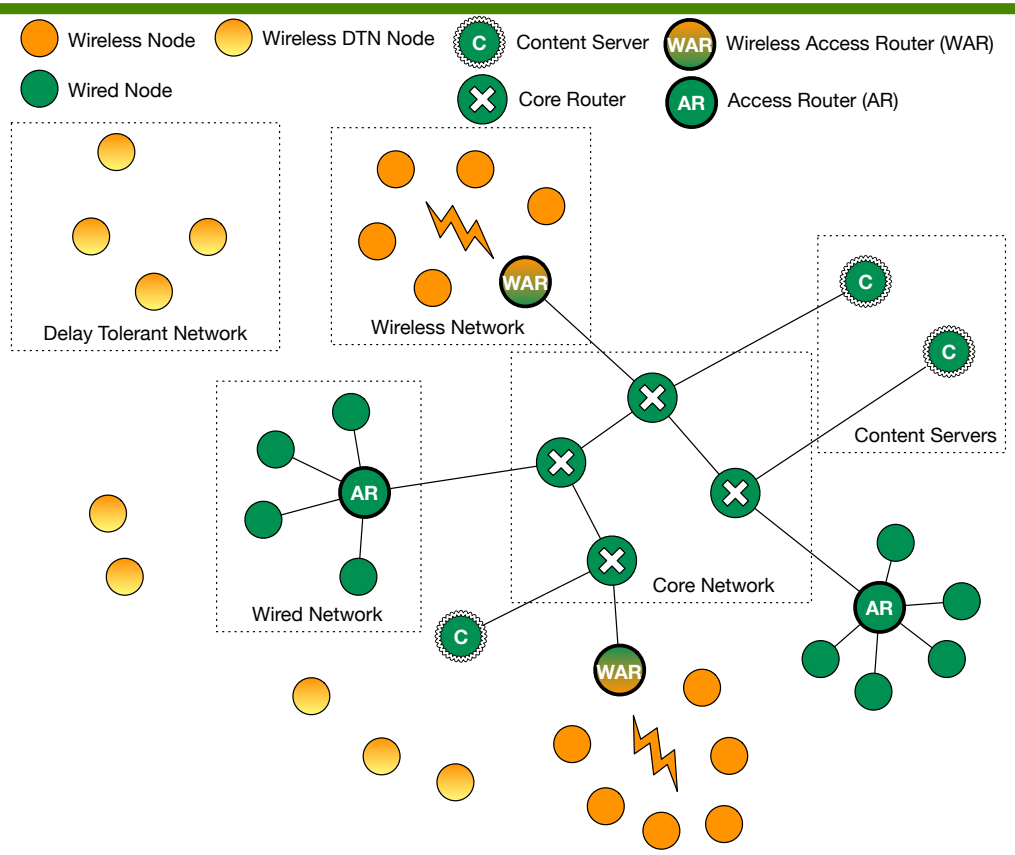


- Applications
  - **ContentDownloadApp** – application to download content
  - **ContentServerApp** – application to serve hosted content
  - **PrefixAdvertiser** – content prefix dissemination protocol

Node Architecture and Layer Models

- Forwarding
  - **RFC8569Forwarder** – Implements forwarding as in RFC8569
- Transports
  - **WiredTransport** – handles wired connections (faces)
  - **WirelessTransport** – handles wireless connections (faces)
- Mobility
  - INET based mobility models
- Numen
  - Global information of a node

Node Models



- **Wireless Node** – a simple CCN wireless node
- **Wireless Access Router** – a CCN access router for wireless nodes

Node Models

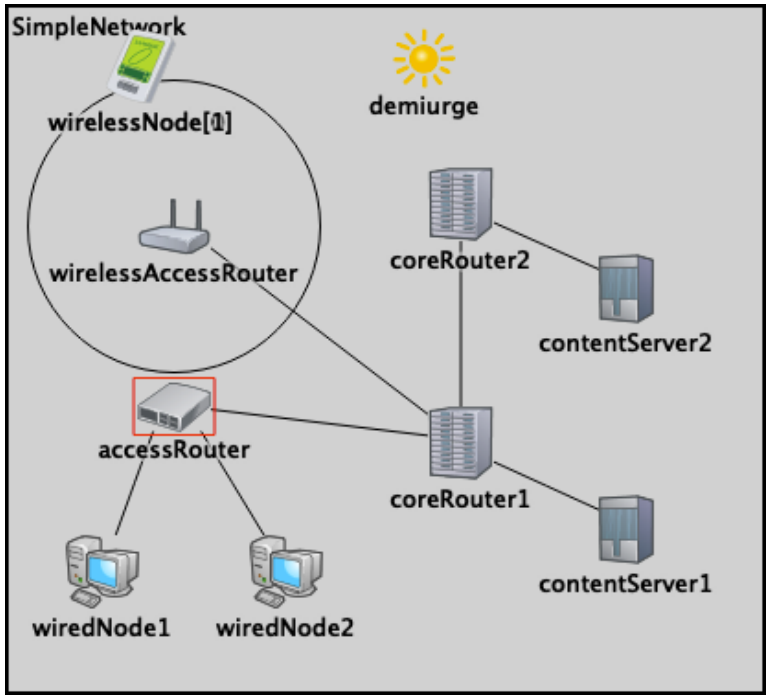
- **Wireless DTN Node** – a wireless CCN node with direct communication capabilities (such as in WLAN, Bluetooth)
- **Wired Node** – a wired CCN node
- **Access Router** – a CCN router for wired nodes
- **Content Server** – a CCN server hosting content
- **Core Router** – a CCN router similar ones operating in the Internet backbone

Metrics

- **Cache Hit/Miss Ratio** – the ratios of hits and misses of cache searches
- **Content/Segment Download Duration** – an average durations of content and segment downloads
- **Interest Retransmissions Received/Sent** – counts and bytes of Interest retransmissions
- **Average PIT Entries** – the changes to count of PIT entrie over time

Performance Evaluation

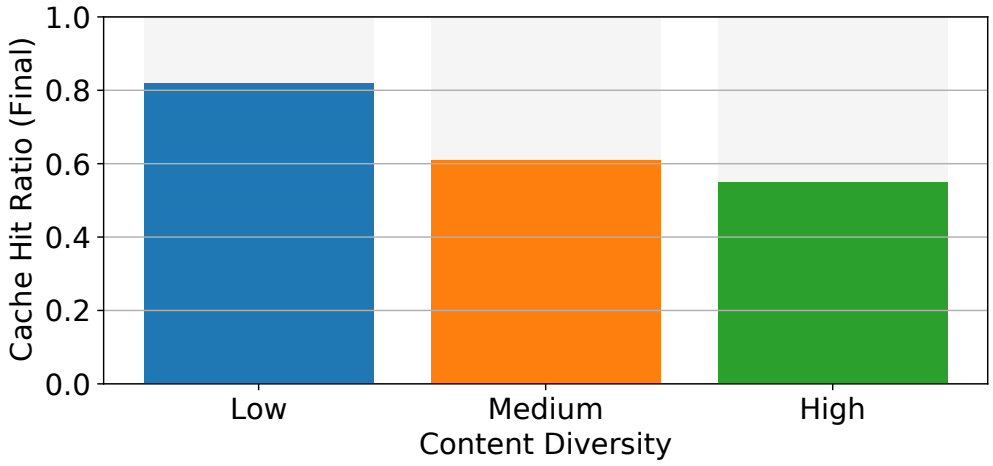
Evaluation Scenario

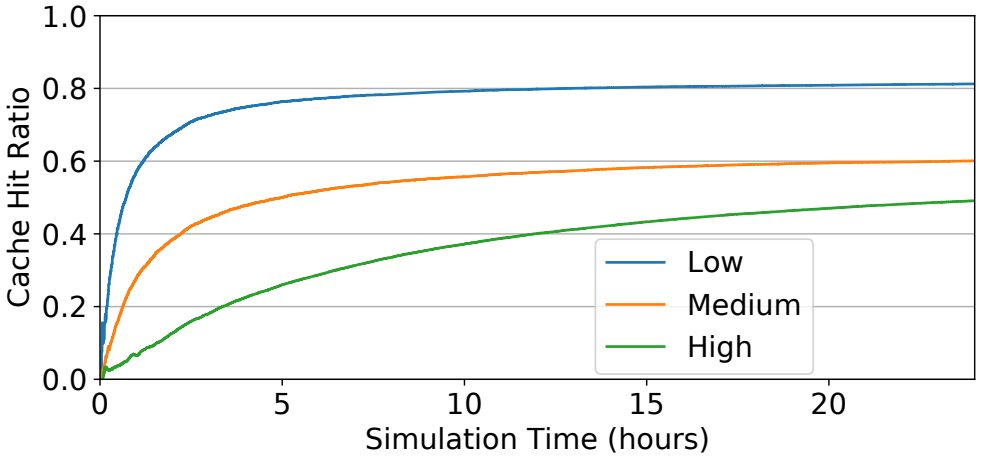



```
[Config Simple-Net-High-contents]

**.nextFileSuffix = intuniform(0, 200, 3)

[Config Simple-Net-Medium-contents]

**.nextFileSuffix = intuniform(0, 100, 3)


[Config Simple-Net-Low-contents]

**.nextFileSuffix = intuniform(0, 50, 3)
```

- Multiple wired and wireless nodes
- Content servers hosting content
- Core routers to cache and forward content
- 3 scenarios – with different content catalog sizes

Results





- Increase of content diversity degrades hit ratio
  - Smaller the content catalog size, lesser the selection choice
  - Therefore, more likely to find previously cached content
- Caches build up gradually
  - Caches are empty at the beginning
  - Gradually reaches a ceiling (based on caching policy, content expirations, cache sizes)

Summary and Future Work

Summary and Future Work

- Content retrieval orientation of communications
  - Internet is used to move content
  - CCN for named content, instead of named hosts
- Importance of CCN
  - IETF standardization – recent RFCs
- OMNeT++ model framework
  - Implements the IETF RFCs
- Code available at GitHub
  - https://github.com/ComNets-Bremen/inbaverSim
- Future Work
  - Immediate – caching policies, prefix dissemination, etc.
  - Long-term – operate in intermittently connected network, sensor networks, vehicular networks, etc.

Thank You for your Attention

Questions?