Flexible Access System Architecture (FASA) for the Next-Generation Optical Access Network Development

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Outline

- **Trends in broadband access services and technologies**
  - Trend in broadband services in Japan
  - New broadband strategy in NTT and new services combining mobile and fiber
  - Evolution of mobile broadband technology and mobile fronthaul

- **Flexible Access System Architecture (FASA)**
  - Operators’ issues
  - FASA – concept, architecture, etc.
  - Use cases
  - Related works
  - Access Network Slicing

- **Summary**
Trends in broadband services in Japan

Number of subscribers

- ADSL
- FTTH
- CATV
- BWA
- LTE

BWA: Broadband mobile wireless access using 2.5-GHz band ~ Mobile WiMAX
Reference: An announcement from Japanese Ministry of Internal Affairs & Communications
New broadband strategy in NTT

- NTT has changed the broadband business strategy from B2C (Business to Customer) to B2B2C (Business to Business to Customer).
- We have started wholesaling fiber access according to this strategy.
  - This business model is called “Hikari Collaboration Model”.

Supporting a variety of market players to create new value

- B (Service Provider)
  - Mobile, MVNO, ISP, Players in other industries etc.
  - Wholesale of FTTH
  - Partner’s own service
    - FTTH service
    - Providing service by single package
      - “Creation of Value”
  - Improve customer’s convenience

- C (Customers)

- B (NTT EAST, NTT WEST)

- B (Flet’s Hikari (FTTH))
  - Wholesale of FTTH
  - Retail

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Number of partners and end users

- The number of partners exceeded 300 in NTT East.
- The partners include MNOs, MVNOs, ISPs, local cable-TV operators, rental-video companies, etc.

Number of partners and end users in the Hikari Collaboration Model (in NTT East only)

https://www.ntt-east.co.jp/info/detail/160324_01.html
New services combining mobile and fiber

- Mobile network operators start providing (1) more affordable rates, (2) one-stop service and (3) new services combining mobile and fiber using the wholesale FTTH infrastructure.

Affordable, Easy and Convenient!

Video Communication Connecting Friends & Family

Share emotional moments with friends and family using easy-to-use live streaming with high sense of reality

### Evolution of mobile broadband technology

<table>
<thead>
<tr>
<th></th>
<th>LTE (3.9G)</th>
<th>LTE-Advanced (4G)</th>
<th>5G</th>
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<tbody>
<tr>
<td><strong>3GPP std.</strong></td>
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<tr>
<td>Release</td>
<td>Release 8, 9</td>
<td>Release 10 to 13</td>
<td>Release 14, 15</td>
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<tr>
<td><strong>Commercialization</strong></td>
<td>Dec 2010 (NTT docomo)</td>
<td>Mar 2015 (NTT docomo)</td>
<td>2018 to 2020?</td>
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<td><strong>Maximum speed</strong></td>
<td>Commercial</td>
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<td>per User Equipment</td>
<td></td>
<td>75~150 Mbps</td>
<td>250~500 Mbps</td>
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<td></td>
<td>Standard</td>
<td>~300 Mbps</td>
<td>~4 Gbps (~26 Gbps)</td>
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<td></td>
<td></td>
<td></td>
<td>~10 Gbps</td>
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<td><strong>Frequency bands</strong></td>
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<tr>
<td>(in Japan)</td>
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<td>700 to 900MHz, 1.5 to 2.1GHz, etc</td>
<td>2.5GHz band, 3.5GHz band, etc</td>
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<tr>
<td></td>
<td></td>
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<td>Also over 6GHz?</td>
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<td><strong>Technologies</strong></td>
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<td></td>
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<td>• Carrier Aggregation</td>
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<td></td>
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<td>• Inter-cell coordination</td>
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<td>• Small-Cell Enhancement</td>
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<td></td>
<td></td>
<td>• C/U split Etc</td>
<td>• New Radio Access Technologies (New RAT)</td>
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<td>• Massive MIMO Etc</td>
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</table>
RAN for the 4G and 5G mobile services

4G~

Small cells (e.g. lower SHF; <6GHz)

5G~

Small cells (e.g. lower SHF; <6GHz)

Spot cells (e.g. higher SHF; >6GHz, EHF band)

References

TWDM-PON for dense small cells (1/2)

- TWDM-PON in ITU-T G.989 series (NG-PON2) will allow concentration and dispersion of wavelength resources.
- In the next generation fronthaul, the optical bandwidth per cell changes depending on the amount of real traffic, for which the bandwidth and wavelength resources can be properly assigned.
The wavelength resources can be re-allocated to adapt to the concentration or the dispersion of the traffic according to users’ travel.
Future optical access systems

Support of emerging new services by VNOs

Support of small cells and spot cells by MNOs

Diversification of services and requirements

Optical Access Systems will evolve from FTTH infrastructure to the common access platform for various VNOs/MNOs

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- Summary
Operators’ issues

Evolving services
(5G mobile, next-gen wireless LAN, etc.)

Various access schemes

MNO: Mobile Network Operator
FTTB: Fiber To The Business

Vender-dependent and single-purpose equipment

- It is difficult to quickly add/change functions for new services.
- It is difficult to customize functions to each retail provider in case of wholesaling access.
- Inaccurate demand forecast leads to wasteful investment or shortage of each equipment.
FASA – Flexible Access System Architecture

- NTT’s new concept to address these issues by the help of virtualization technologies.

References
Etc.
APIs for FASA

- In order to enable simple and easy function add-on, a commonly usable APIs (Application Programming Interfaces) are very important.

**Reference**
Use case of **FASA**: Residential service

- FASA provides broadband service for residential customers, same as the current systems.
- FASA aims to **flexibly update/replace the functions** (e.g. DBA) by updating a software without rebooting the OLT/ONUs.

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**CO**: Central Office  
**DBA**: Dynamic Bandwidth Assignment  
**PS**: Power Splitter  
**SR**: Status Report

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*K. Asaka and J. Kani, Contribution in FSAN Louisville meeting, June 2016.*
Use case of **FASA**: 5G mobile fronthaul (MFH)

- In 5G mobile system, dense small cells could be accommodated by a PON as MFH, which has an advantage in terms of low CAPEX of physical infrastructure.
- By replacing the DBA software from SR-DBA to LL-DBA, TDM-PON-based MFH can be realized. This avoids re-building the OLT from the beginning.

**CU**: Central Unit  
**LL**: Low Latency  
**RU**: Remote Unit  

Central Office Re-architected as a Datacenter (CORD)

- A collaborative effort between **AT&T** and the **Open Networking Lab** (ON.Lab).
- The goal is to allow Telcos to benefit from both
  - **the economies of scale** (infrastructure constructed from a few commodity building blocks) and
  - **the agility** (the ability to rapidly deploy and elastically scale services).

**References**
- Presentations in ONS Inspire! Webinar “CORD: Central Office Re-architected as a Data center,” Nov 17, 2015.
Challenges for deeper softwarization

• Presentation W3F.1 in this OFC proposes virtualization of EPON OLT functions with a challenge to realize software-based Multi-Point MAC Control (MPMC).

Evolution of FASA

- Modularization of various functions is highly expected in the near term.
- Further discussions in forums and standard bodies are expected on (1) which functions should be virtualized and (2) how deep the access network functions should be softwarized.
Virtualization of mobile functions: Virtual Broadband Unit (vBBU) in C-RAN

- Advantages
  - Computation resources can be flexibly allocated to each virtual BBU on demand.
  - The BBU function can be dynamically reconfigured and adjusted.

Reference
Modularization, softwarization and virtualization make it easy to realize the access network slicing. This will drive the construction of the common access platform for various VNOs/MNOs.
Summary

- Optical Access Systems will evolve from FTTH infrastructure to the common access platform for various VNOs/MNOs

- Flexible Access System Architecture (FASA) based on modularization of access-network functions will address diversification of services and requirements.
Thank you for your attention!