200G/400G FR4 Large-Scale Deployment in Meta’s Data Centers

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Agenda

- Meta DC Growth/Monthly Active Users (MAU)
- Mass production: 200G/400G FR4 Optics (lessons learned)
- Fleet Tooling & Performance Monitoring @Meta Data Center
- Long-Term Reliability Plan (Pluggable Optics)
- Global Material Crisis & Risk Mitigation Effort
- Future opportunities & Next Gen
Meta User and DC growth
200G/400G Deployment by Quarter

200G FR4 Deployment

400G FR4 Deployment
200G Optics Link Failure Modes

- 26% of the link failures are real 200G optics failures
- 26% of the link failures are caused by dirty fiber connectors
- The 200G optics failure rate is well below our requirement
200G/400G - Lessons Learned

- Solid NPI process helped capture the module failures at early stages – No real module performance issue observed in the operation.

- Detailed PRD and validation for both performance and diagnostic support

- Efficient operational tooling and process provided a timely and accurate triaging of link issues

- Need to improve the internal reliability regression testing capability

- Resilience to the "black swan" events (e.g. Covid-19, natural disasters)

- Need to improve suppliers' MFG site monitoring processes
Efficient RCA with Improved Tooling and Processes

- We have significantly improved RCA process over the last 2 years on optical and non-optical link failure events.
Key Module Performance Monitoring in Operation

- The optical DDM information is monitored in operation and used for link triaging.
- Operation tooling such as performance dashboards provides various ways of checking the link performance.
Tooling and Performance Monitoring: Meta Defined Supplier Mfg. Test Data

Mfg. Analytic Platform (MAP)

What
- Out of box module test data
- Monitor distribution of parameter with an eye for outliers.

Why
- Cpk (process capability index) trends
- On time delivery
- Data variation, Channel dependence, MPN dependence

Cpk trend

PN dependence

Ch dependence
Tooling and Performance Monitoring: RMA

What
- Track NTF vs Real failures
- DPPM, FIT, Corrective actions

Why
- Main failure mode
- Track RMA TAT
- Effectiveness of CA
Tooling and Performance Monitoring: Meta Data Center

Inline monitor

What
- Module parameter tracking
- Swap rate

Why
- Track fleet health

Fleet → Monitor

ASR → Monitor

Module parameter tracking
Swap rate

Track fleet health

ASR

Tx_Pwr

Temp
Tooling and Performance Monitoring: ORT

**ORT**

**What**
- Design robustness and corner tests
- Performance Test/Traffic

**Why**
- Track vendor ongoing reliability

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**ORT Test Structure**

- **Contd. Design Robustness (quarterly)**
  - High Temperature Storage
  - High Temperature Operating Life
  - Mechanical Integrity
    - Temp Cycle
    - Shock
    - Vibration

- **Performance Test**
  - **Corner Test (quarterly)**
    - Temperature Corners
    - Voltage Corners
  - **Traffic Test (monthly)**
    - RFC 2544
Tooling and Performance Monitoring: Reliability

Long Term Reliability

Monitor

Long Term Reliability

What

Traffic data in oven with temp cycling

Why

Determine long term reliability

Tx power trend (40C)
Global Supply Shortage and Mitigation

**Takeaways:**

- Cross-functional resources across 4 workstreams required to navigate unprecedented supply shortages
- Multi-sourcing strategy expanded to address key sub-components

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<thead>
<tr>
<th>CONTRACT</th>
<th>TIER1 (FG) Operations</th>
<th>TIER 1 (FG) Quality &amp; Capacity</th>
<th>TIER2 (Sub-components)</th>
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<tbody>
<tr>
<td>Tier 1 (Source) LTA commitments</td>
<td>P0s &amp; Commitments (Global Supply Chain) Drive PO coverage and commitment review</td>
<td>Mfg, Ramp Enablement (Quality) Mfg, and test capacity ramp analysis, yield improvement, production line throughput and utilization assessment, audits</td>
<td>Dual Sourcing (HW Eng, Quality, Source) (1) Drive decision (2) Dual source critical components via ECN/PCN</td>
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<td>Tier2 (Source) Sub-comp LTA</td>
<td>Ops Standardize &amp; Forecasting (Global Supply Chain) Standardization &amp; ongoing ramp forecasting &amp; commitment process across Tier1 suppliers</td>
<td>Risk Mitigation (Quality) Quality control process Milestone review</td>
<td>Tier2 Supply Coverage (Global Supply Chain, Source) Open orders, LT, Inventory mgmt</td>
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<td>Deployment Impact (Global Supply Chain, Planning) Determine impact to deployment in case of delays</td>
<td>Tariff Mitigation (Quality, HW Eng, Source) Qualifying non-COO supplier sites</td>
<td>ECN/PCN Roadmap &amp; Qual Schedule (Program Mgmt, HW Eng, Quality) Develop qualification plan with key milestones</td>
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<td>Qual Schedules (Program Mgmt) Early Deployments Monitoring (HW Eng., Quality)</td>
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Global Material Crisis/Meta's PCN Process

- Unprecedented component shortages, de-commits, and potential impact to deployment
  - ~3X-4X additional PCNs in 2021 & 2022
- Unique PCN test structures to optimize Meta's internal qualification time
- Virtual mfg. line audits to improve production throughput and quality control
- New mfg. site qualification strategies in record time
Future Opportunities

Supply Chain Flexibility

Drive dual-qualification of key components during NPI

Continuous Improvement

Leverage PCN process to drive continuous improvement in process and design

Feature rich diagnostics for optics and switch HW

Diversify Manufacturing Footprint

Collaborate with supplier partners and leverage Meta PCN process to qualify manufacturing in multiple geographies

## Meta Contributors

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