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PIC Pilot Lines: Competitive Positioning
Michael Lebby
8th November 2021
PIC International: PIC Pilot Line Keynote

Safe Harbor

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This orange bar is the takeaway summary from each slide…

Sit back...relax (no need to take notes!)

3 questions to remember today…

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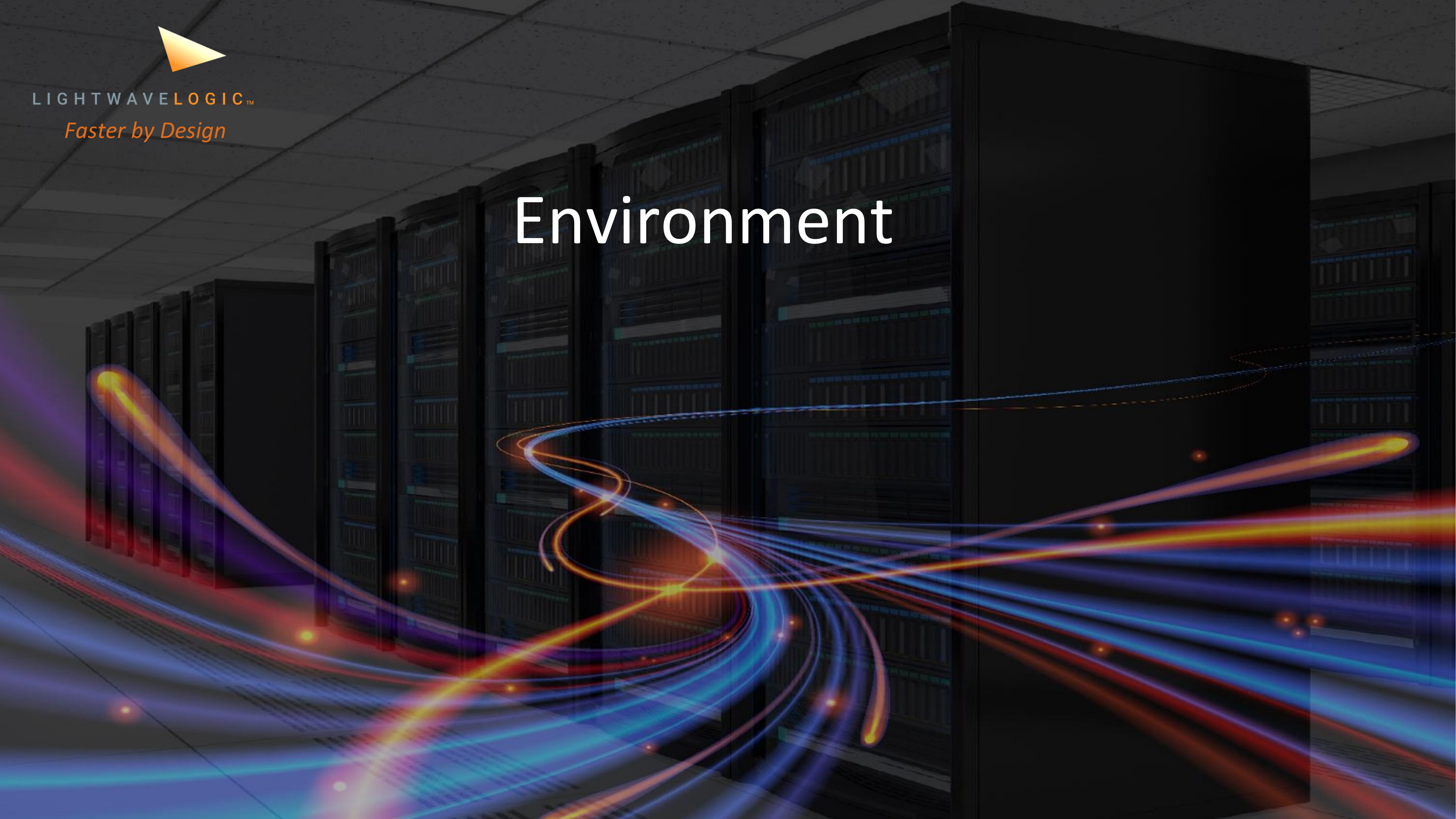
- Can the PIC pilot lines provide product value?
- Can we integrate the PIC pilot lines into a competitive infrastructure environment?
- What's needed to make sure our PIC infrastructure is successful in manufacturing over the next decade?

What might be the impact of PICs over the next decade?

Agenda

- Environment
- Pilot Lines
- Roadmaps
- Creating a PIC infrastructure
- Summary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Environment

Photonics as a catalyst for change in lifestyle…

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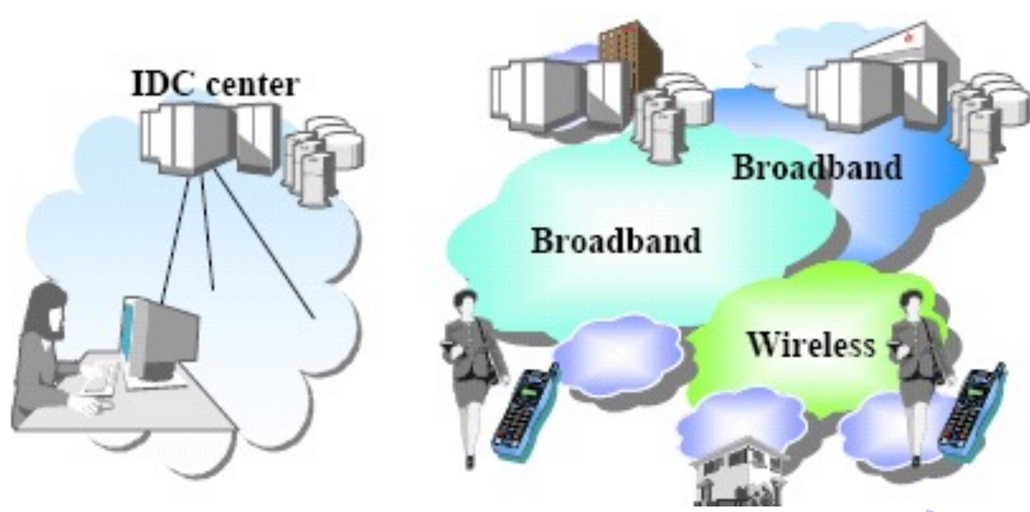

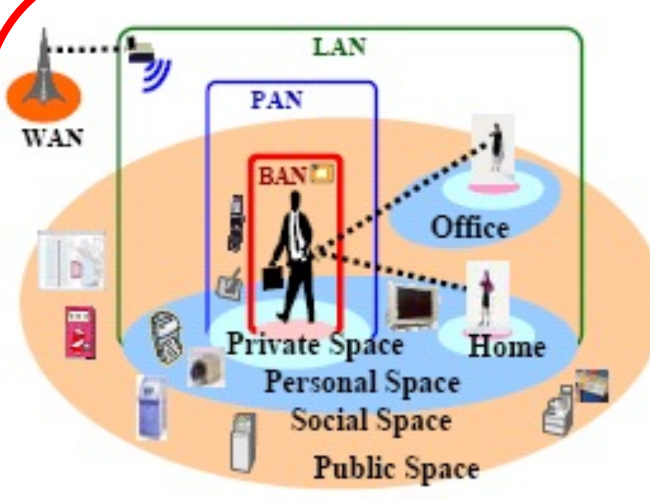

Before	Today	Future
Computer centric	Network centric	User centric
Experts level	Trained level	Pedestrian level
Data exchange	Archival access	Cloud access
Exchange	Datacenter	Hyper-scale datacenter

- Use of photonics
- Use of data…
- Use of displays
- Use of lighting…

Lifestyle evolves towards personal space…

Source: MIC Japan, Fujitsu, NTT; OIDA Research

Photonics markets broaden significantly

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Photonics applications	Photonics → 2030 (rough forecasts*)	Opportunity for PICs (polymer & silicon photonics/InP)
5G systems/back haul/RF	~$4-10B	Existing
Display/project	~$5-20B	Yes
Automotive (LIDAR)	~$20-50B	Yes
Optical sensing/3D	~$2-5B	Yes
Bio-photonic sensing	~$2-5B	Yes
Medical	~$5-10B	Yes
Instrumentation	~$1-3B	Yes
Fiber comms	~$40-60B	Existing
HPC/computational/AI	~$10-20B	Existing
DCI/datacenter	~$20-30B	Existing

Photonics, and PICs in general become ubiquitous over the next decade…

*Source: *Many market forecasts predict huge photonics opportunities; Oculi llc*

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Pilot Lines

Current EU funded Pilot Lines

Seeding a PIC infrastructure

Source: EU Pilot Lines Photonics PPP with Photonics 21

PIC pilot lines

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Pilot Line	Focus	Role	Status
Lyteus (PI Scale)	OLED lighting applications for displays, illumination, automotive	Provide prototyping runs before scale-up	Self-sustaining Open for opportunities
Mid IR Alliance (MIRPHAB)	Mid IR chemical sensor applications	Provide module designs in small volume	Self-sustaining Open for opportunities
PIX4LIFE	Dielectric PICs for bio-photonics and life science	Provide prototype PIC chips for scaling in volume	Self-sustaining Open for opportunities
PIXAPP	PIC packaging platforms for heavy data, medical, sensing	Provide PIC packaging and assembly services for PIC chips	Final year EU funding Open for opportunities
Jeppix (InPulse)	InP PIC foundry	Provide design, fabrication, test services to SMEs	Mid-course EU funding EU assistance on projects
Phabulous	Free-form micro-optics applications	Provide optical lenses for broad applications	Mid-course EU funding EU assistance on projects
MedPhab	Silicon photonics for medical, healthcare applications	Provide healthcare prototypes	Mid-course EU funding EU assistance on projects
Photon Hub	Building a photonics network infrastructure	To support SMEs/pilot line prototypes ramp prototypes	Mid-course EU funding to assist photonics SMEs
ACTPHAST	Creating an early-stage photonics infrastructure	To support SMEs/pilot line create prototypes	Mid-course EU funding to assist photonics academia & SMEs

Source: EU Pilot Lines Photonics PPP with Photonics 21

Key metrics for all pilot lines

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Industrial advisors (Review, advise, feedback)

- Monitor progress/focus on goals; Advise on issues/opportunities/markets

Strategic Issues (Making sure the plan succinct, credible, and fundable)

- Ready for business; Path to sustainability; Product offering, Financial and business model, competition, differentiation, Value proposition, KPIs (key performance indicators).

Demonstration cases (Customer interest → strong motivator)

- Synergies with products; Attracting new customers; Criteria for new applications/demo cases; Showing customers solutions for their business; Innovation for future offering.

Operational structure (Working towards single pilot line architecture)

- Seamless infrastructure with project members; Designing in flexibility; Evaluating maturity of platform technologies; Plans must show scalability, control, quality; Freedom of manufacturing

Open Access (Making it easy to use)

- Ensure openness, especially for SMEs, 'front office'

Publicity, marketing and communications (Market positioning → Reaching your customer)

- Reaching your customer-base; conveying credibility at technology/product shows/exhibits

Strong 'venture capital-like' metrics

Pilot line preparation for self-sustainability

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~4yrs EU funding (it's seed funding)

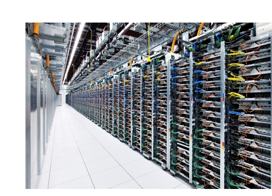
- It's never to early to plan for self-sustainability. Plan for revenue generation in 3rd/4th year before funding expires; finalize legal agreements early (1st /2nd) year

The 1st products…

- What will they be? Like the demonstrators planned, or something different. Will they make money (or support the pilot line)? Have supporting customer interest…

Understand the customer and the market application

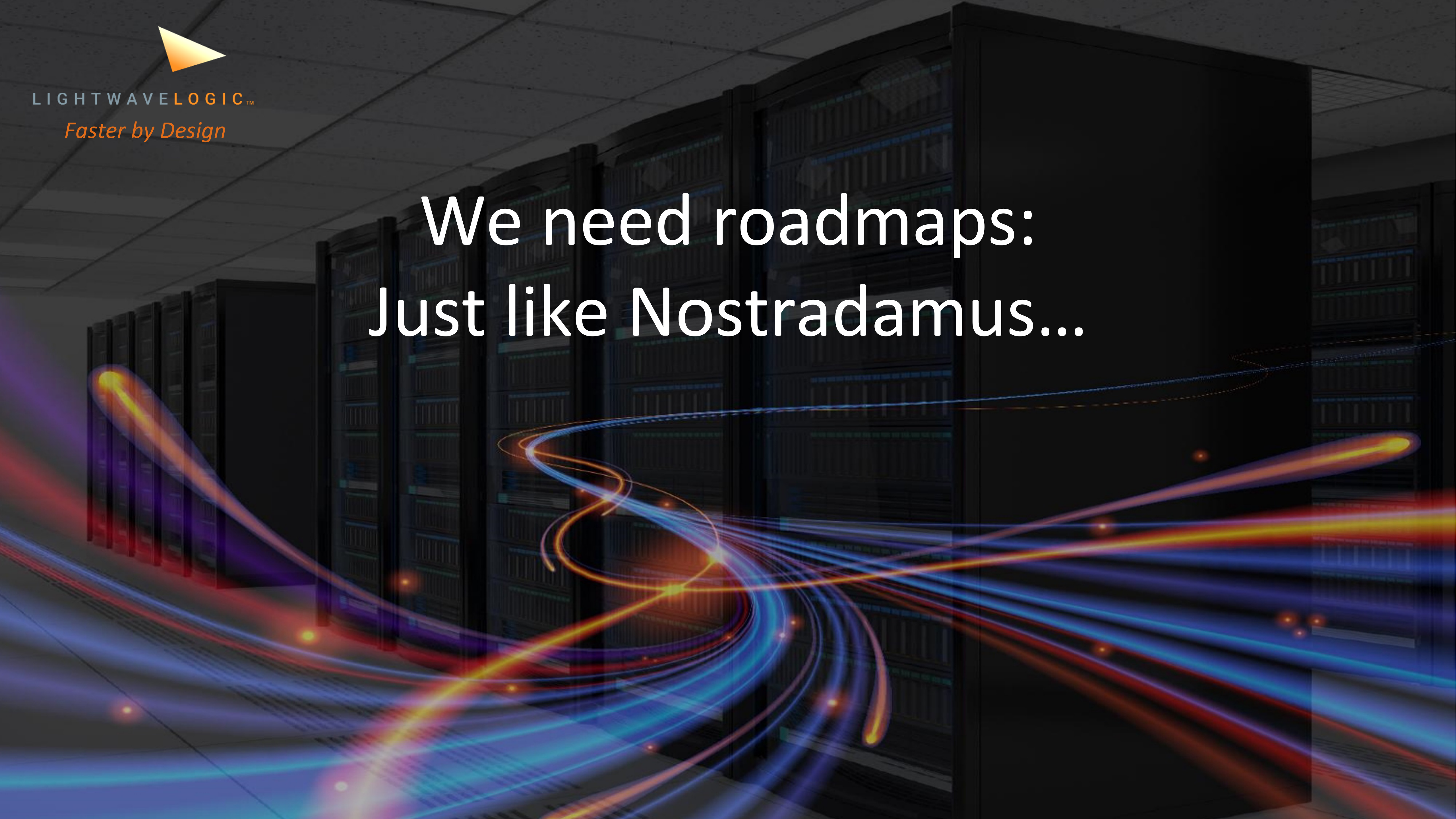
- Are you supplanting the customers manufacturing line? Are you testing out new potential products for them in low volume? Who will get the volume business in the end? Is the market really ready?



Utilizing the support eco-system

- Leveraging PIC pilot lines, digital hubs, hybrid foundries, packaging and assembly houses

Positioning for self-sustainability → provide value in the manufacturing infrastructure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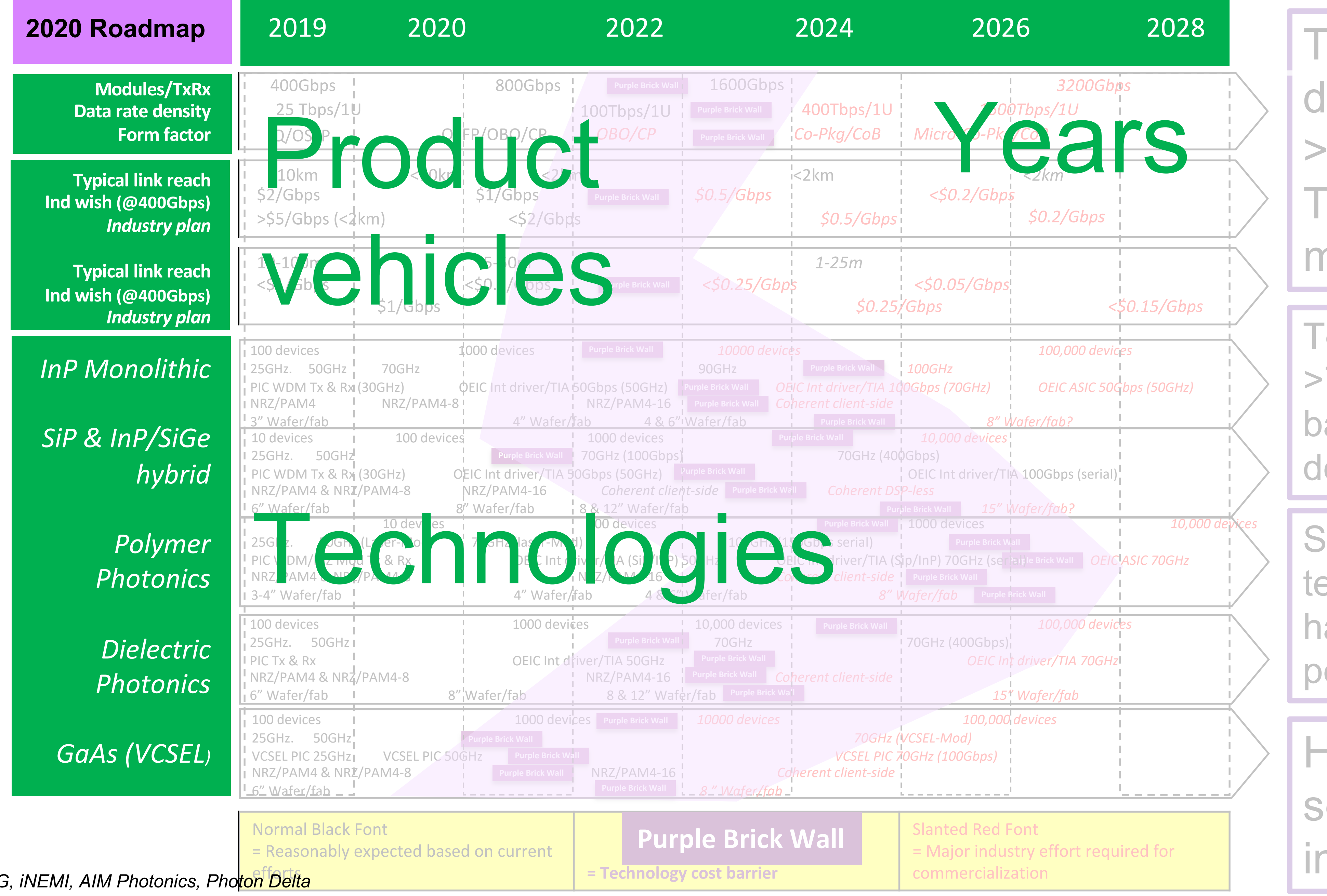
We need roadmaps:
Just like Nostradamus…



Tough to design >1600Gbps+ TxRx modules…

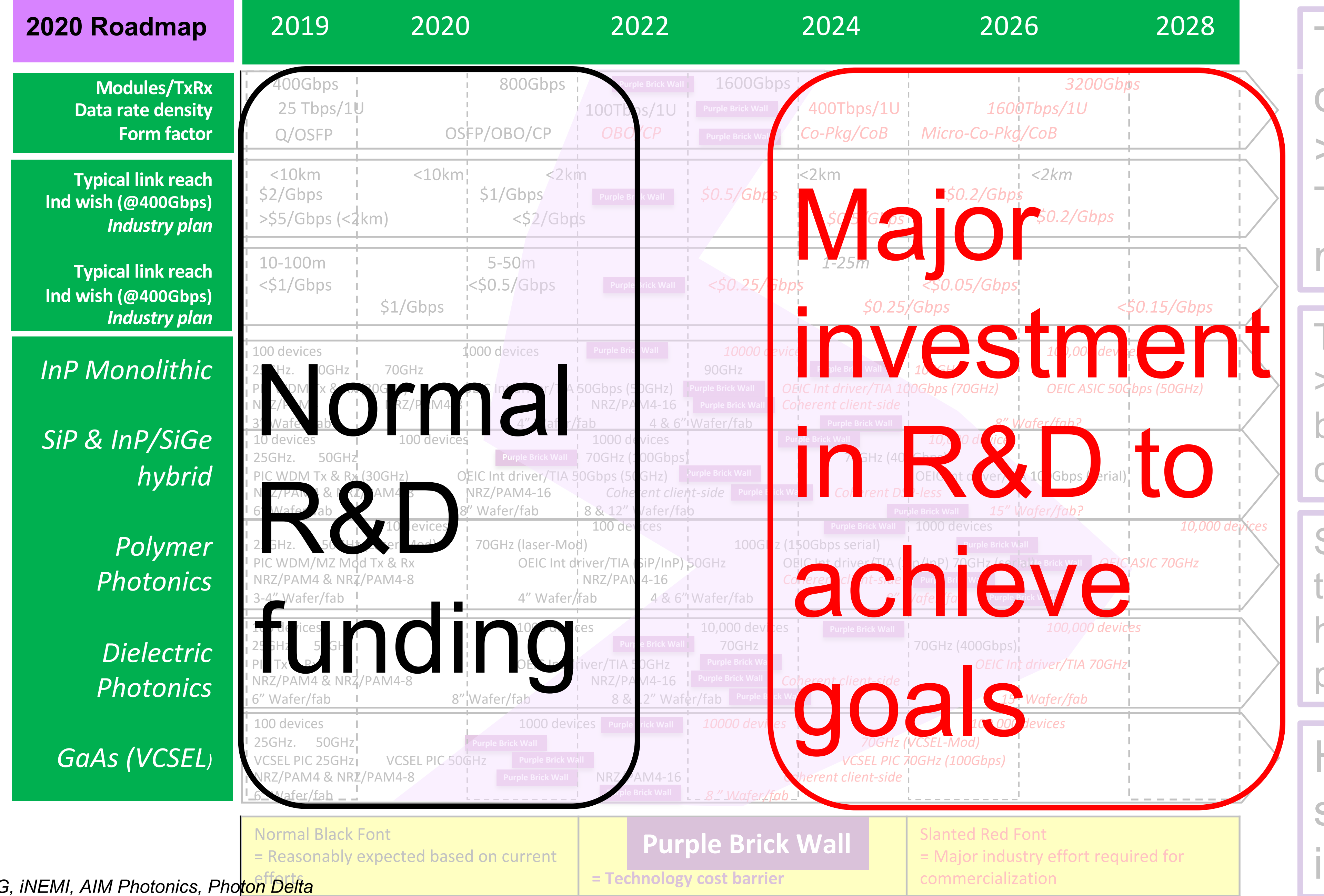
Tough to design >70GHz bandwidth devices…

Some technologies have higher performance….

How to scale PIC integration?

Sources: LWLG, iNEMI, AIM Photonics, Photon Delta

Simple metrics



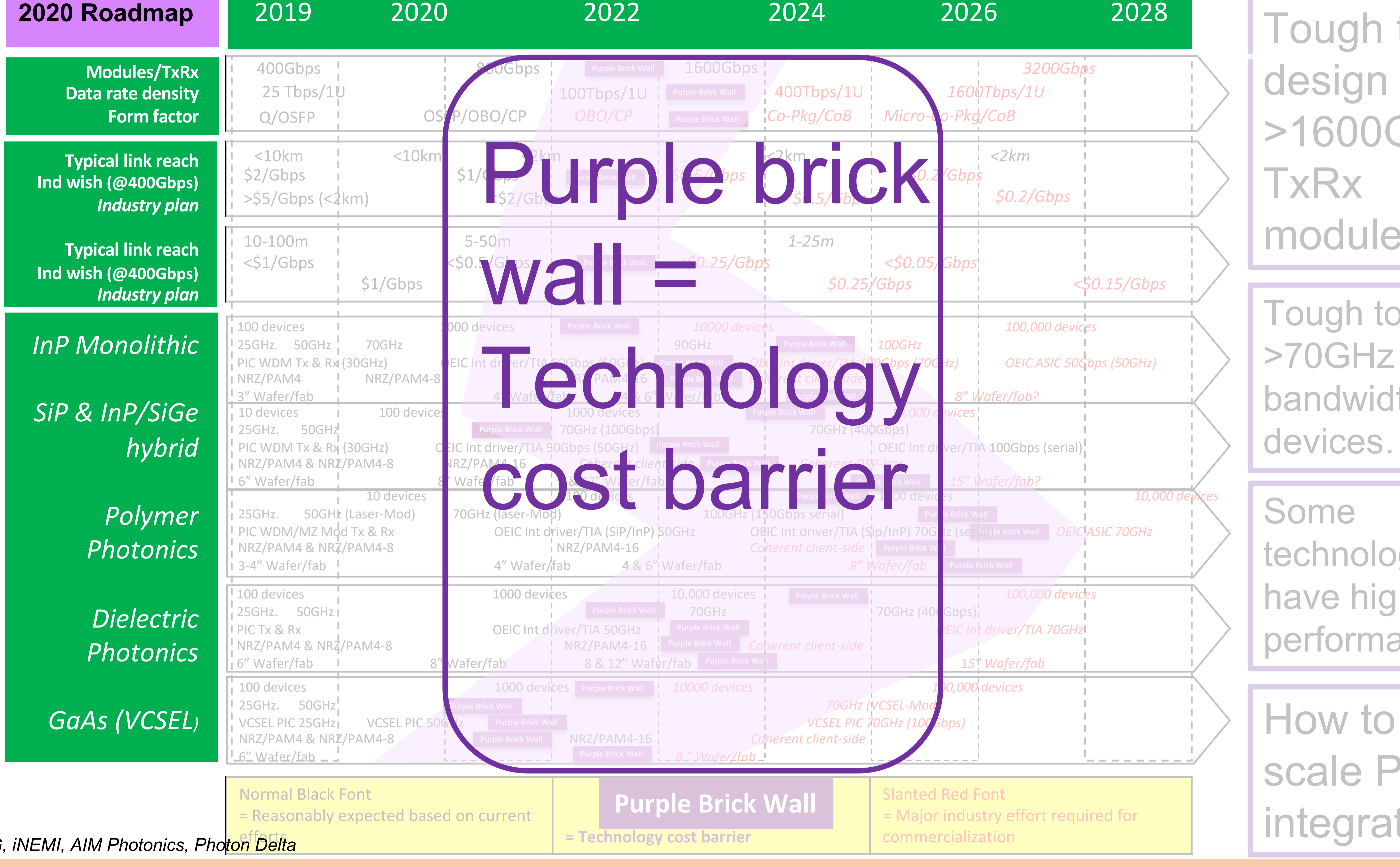
Tough to design >1600Gbps+ TxRx modules…

Tough to design >70GHz bandwidth devices…

Some technologies have higher performance….

How to scale PIC integration?

Red means major industry efforts needed for commercialization



Sources: LWLG, iNEMI, AIM Photonics, Photon Delta

We may have photonics technology → but not at a cost for commercialization…

Advice on a 1-page roadmap…

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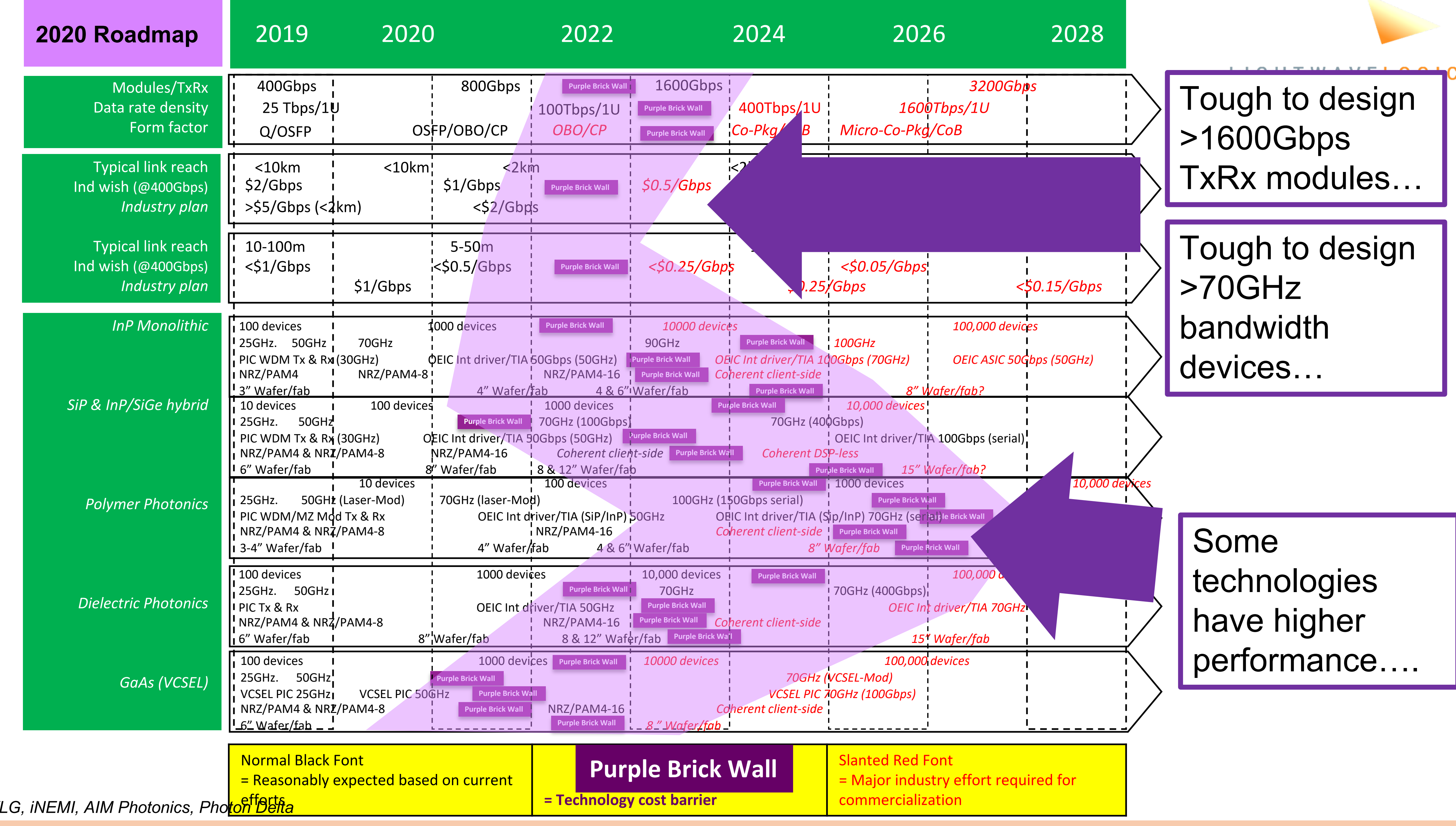
- Huge amount of data and small font…1-page…
- Details can be better viewed better *online*

Roadmaps provide a vehicle for all stakeholders: Gvt, industry, academia, bankers and investors…

Sources: LWLG, iNEMI, AIM Photonics, Photon Delta



Where we penetrate the 'Purple Brick Wall'?

How about a new 1-page roadmap?

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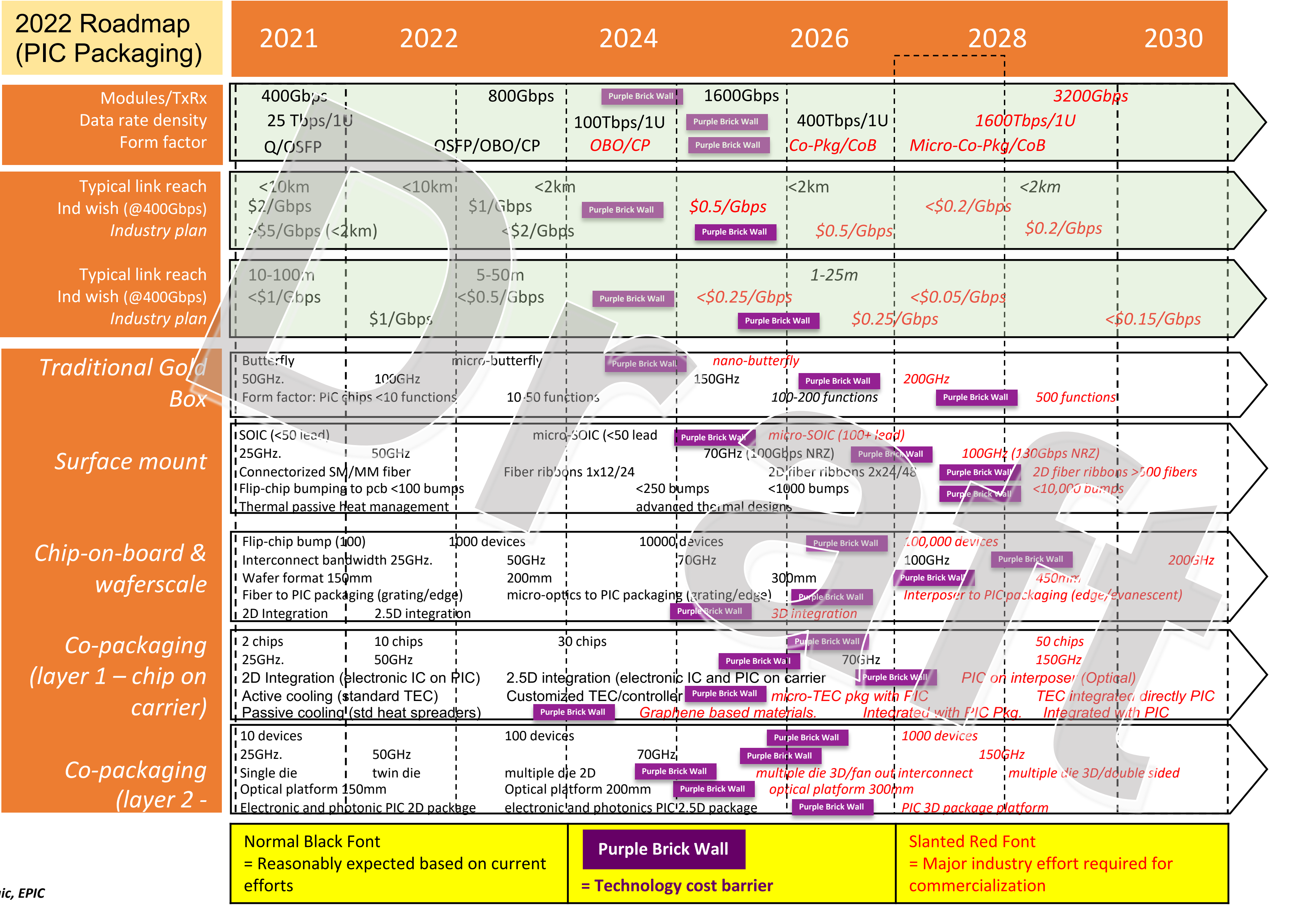
- A *1-page PIC packaging roadmap*…
- Details can be better viewed better *online*

Simple 1 slide roadmaps – have impact

Sources: LWLG, iNEMI, AIM Photonics, Photon Delta



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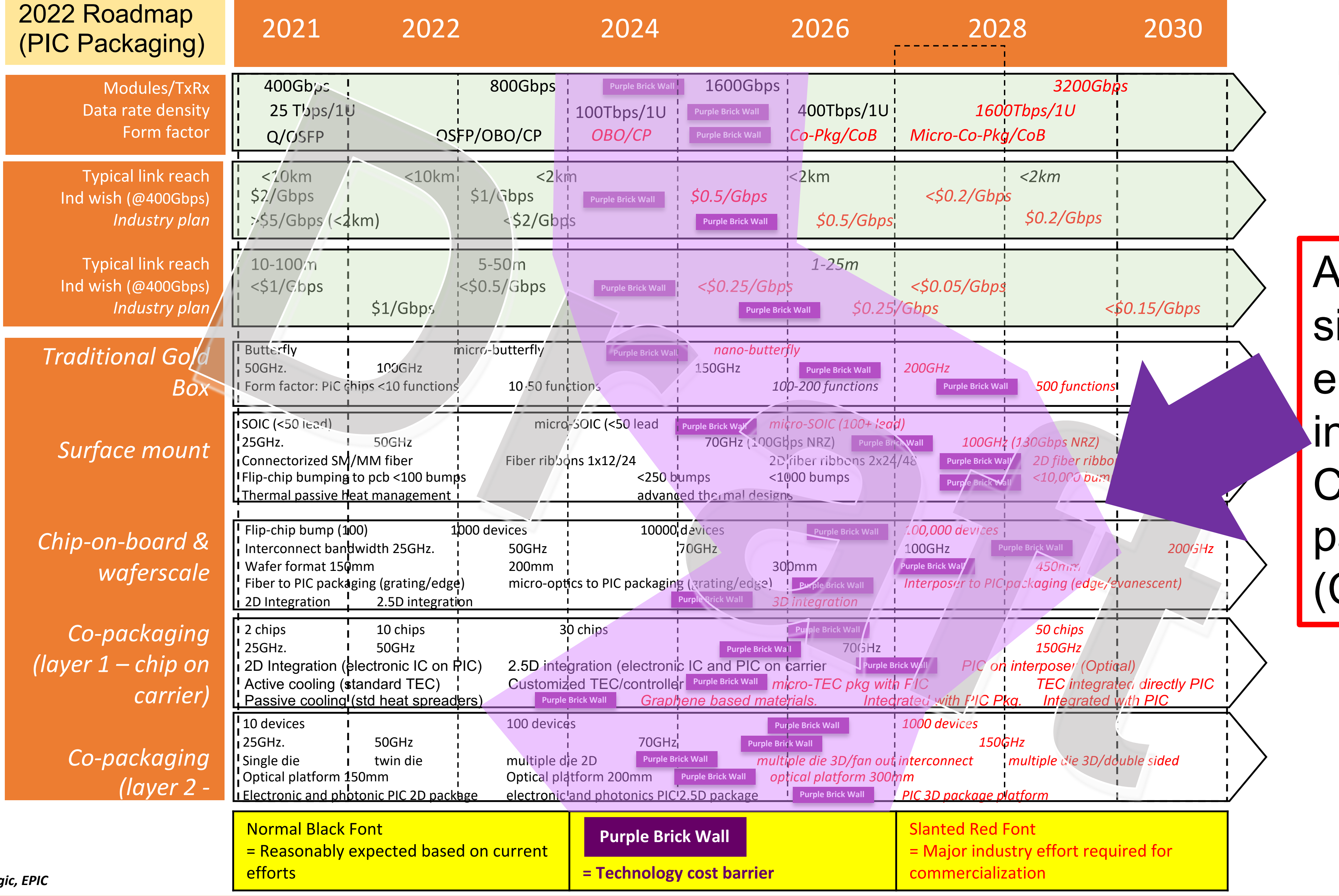
Source: Lightwave Logic, EPIC

A PIC Packaging roadmap…



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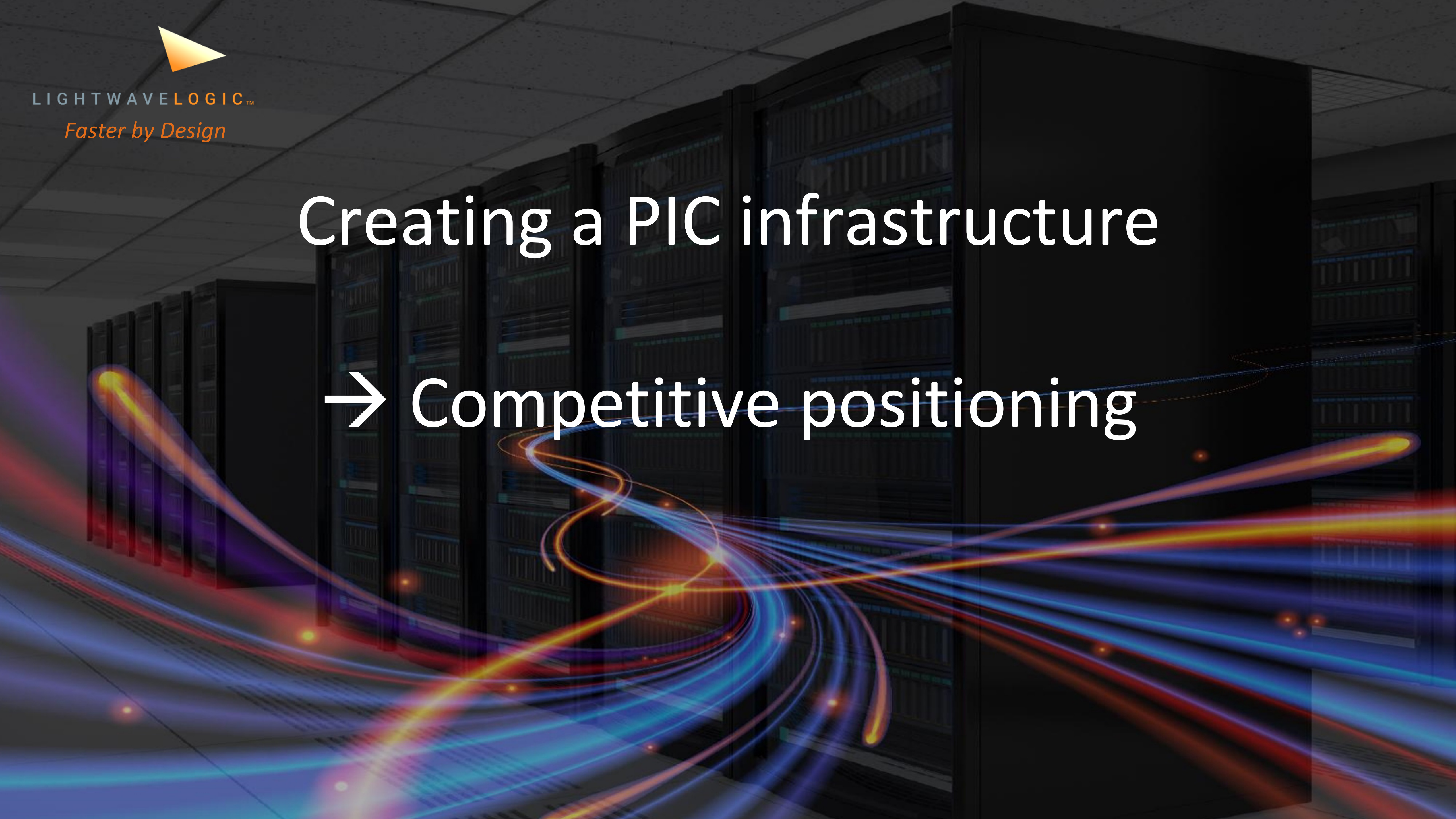
As per the silicon electronics industry → Chip scale packaging (CSP-TAP)

Source: Lightwave Logic, EPIC

A PIC Packaging roadmap…trends towards chip scale packaging/Testing-Assembly-Packaging (CSP-TAP)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Creating a PIC infrastructure
→ Competitive positioning

Creating leadership with the pilot lines...

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How to win?

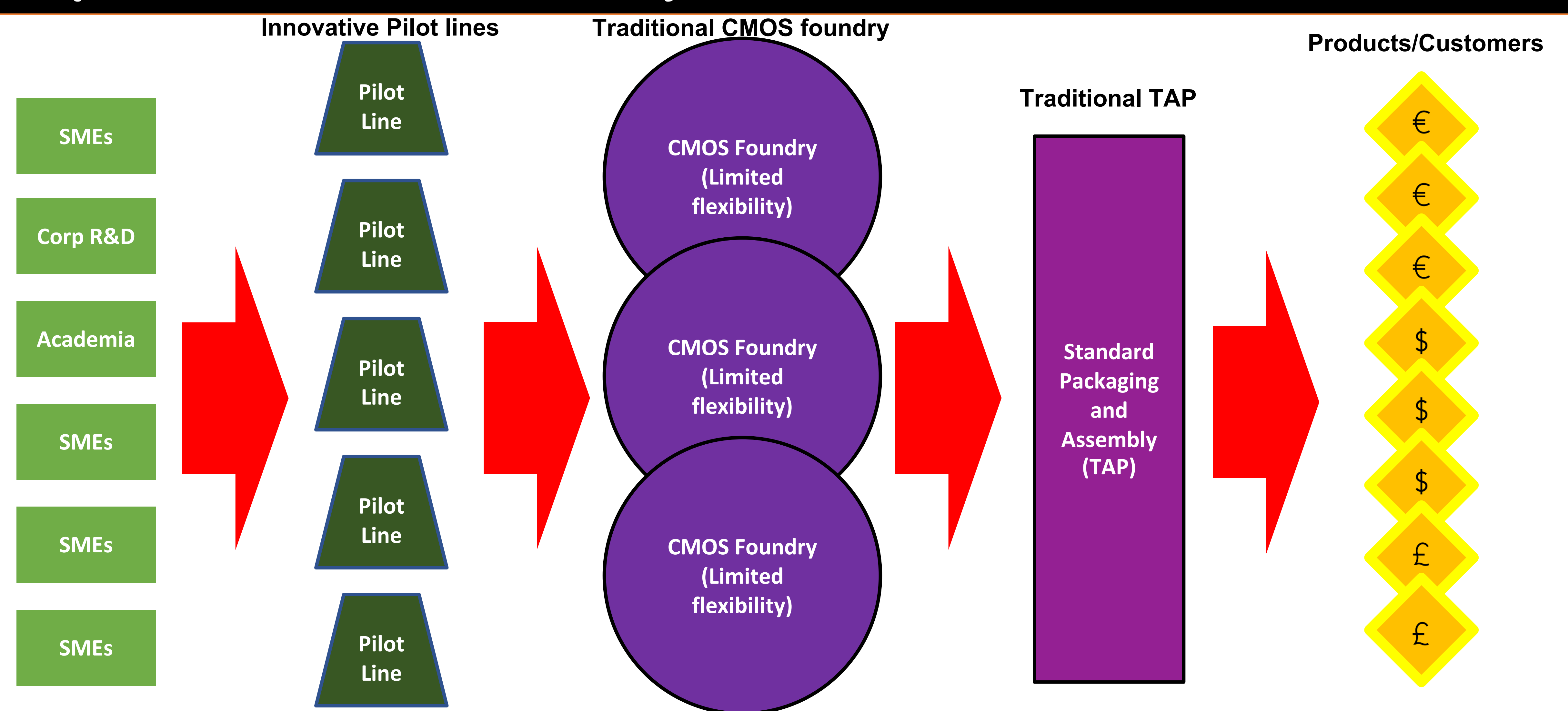
Report Card

- *Provide easier access for SMEs…they drive innovation…*
- Create more PIC pilot line scale projects…that impact growing markets
  - Auto, medical, sensing, display etc.
- Create a sharper focus…*foundries for PICs*
- Create PIC packaging centers…for chip-scale packaging
- Utilize the framework of digital hubs… e.g. PhotonHUB

Build into a global center of excellence…

Pilot lines for PIC: PIXAPP, PIX4LIFE, PI-SCALE, MIRPHAB, PHABULOUS, MEDPHAB, Jeppix, PhotonHub, ACTPHAST

Simplified route for PICs today...



Limited flexibility with foundry and packaging/TAP

“Weaknesses” in PIC ‘Hub-Spoke’ architecture

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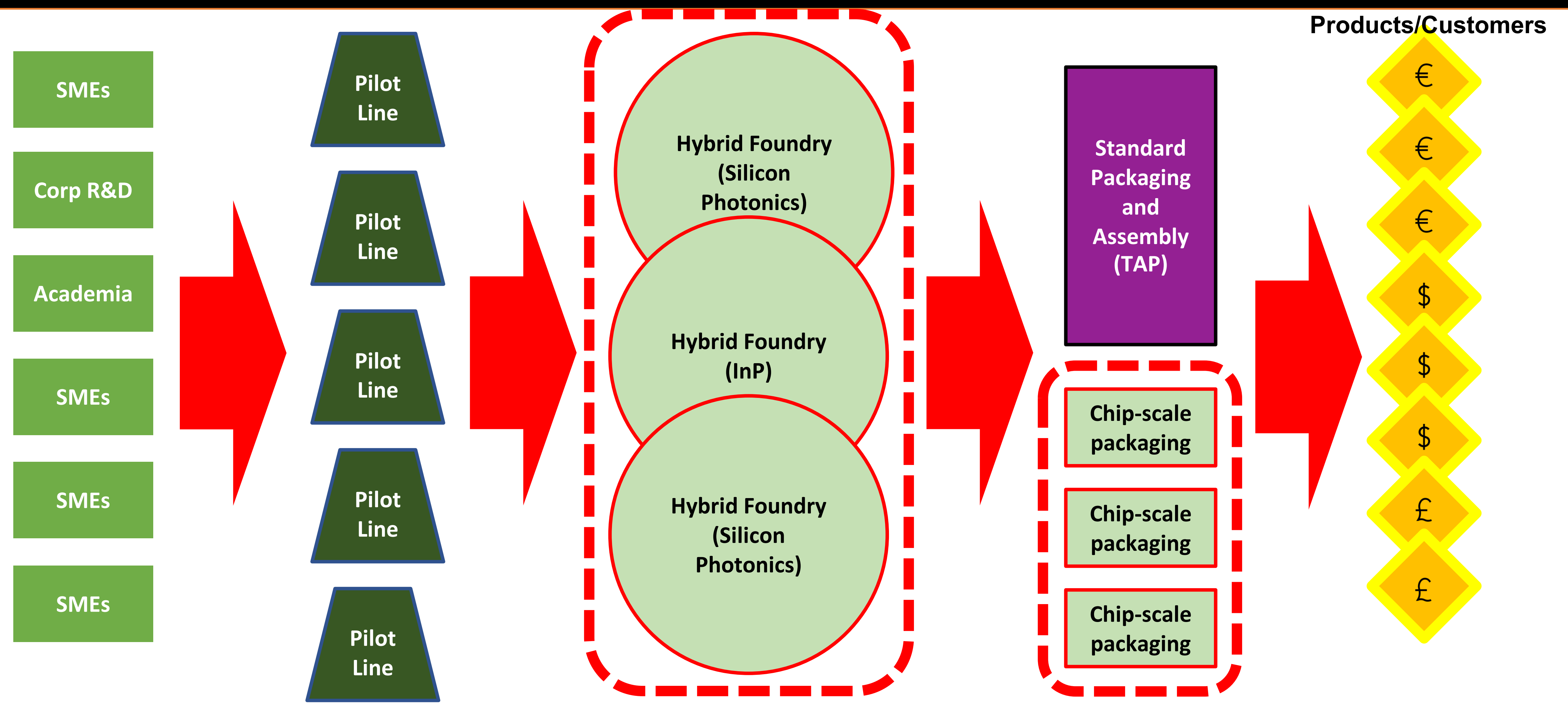

More flexibility is needed for PICs to harness more performance

Roadmaps point to *hybrid PICs*

- Hybrid PIC
  - It is not a pure play PIC (i.e. not pure InP or pure silicon photonics)
  - It is a mix and match of dissimilar technologies to ***improve overall performance***
  - Examples are lasers, SiGe, electro-optic polymers, dielectrics, glass, Barium Titanate, Lithium Niobate, Plasmonics etc.
- Hybrid Foundry
  - A foundries that can run the base PIC platform (e.g. silicon photonics, InP, GaAs) and is ***flexible to run other dissimilar technologies*** that improve overall performance.
  - The trade-off is between standard CMOS PDKs and innovative PICs that require novel PDKs
- Chip-Scale-Packaging/TAP (CSP-TAP)
  - Follow the electronics route and discard the package – mount the chips directly to the sub-mount/pcb; use optics in the pcb…

Adding Hybrid foundry and CSP/TAP center to strengthen the infrastructure…

Sources: LWLG

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Summary

3 questions to remember today…

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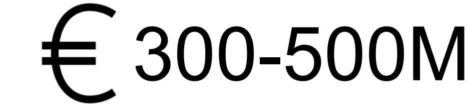
- Can the PIC pilot lines provide product value?
  - YES…and we need more of them…
- Can we integrate the PIC pilot lines into a competitive infrastructure environment?
  - We can but the PIC infrastructure is not quite complete…
- What's needed to make sure our PIC infrastructure is successful in manufacturing over the next decade?
  - At least 1 hybrid foundry…more PIC pilot lines
  - Chip-scale-packaging/TAP house for PICs…



Creates a competitive, innovative, flexible EU PIC infrastructure…and highly differentiated…

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Back-up

Key PIC technology platforms

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- Historic incumbent:
  - InP (Indium Phosphide)
  - GaAs (Gallium Arsenide)
- New incumbent:
  - SiP (Silicon photonics)
- ***New platforms and hybrid accelerators for PICs***
  - *Polymer, dielectrics, glass, lithium niobate thin film, plasmonic, barium titanate, silica, germanium etc.*

Silicon photonics is the new kid on the block; new platforms → hybrid PICs

Sources: LWLG

Sample global players and their PIC platforms

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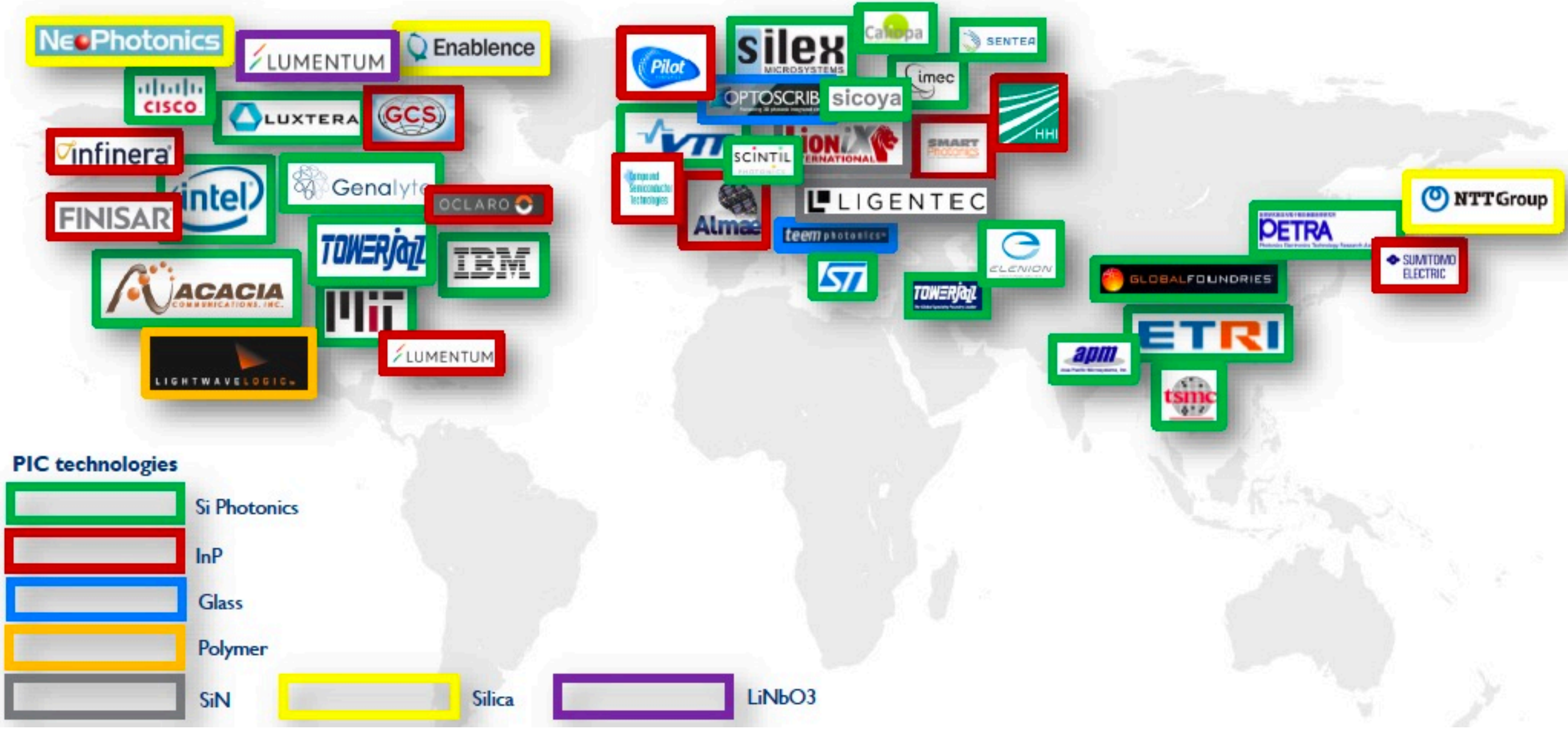
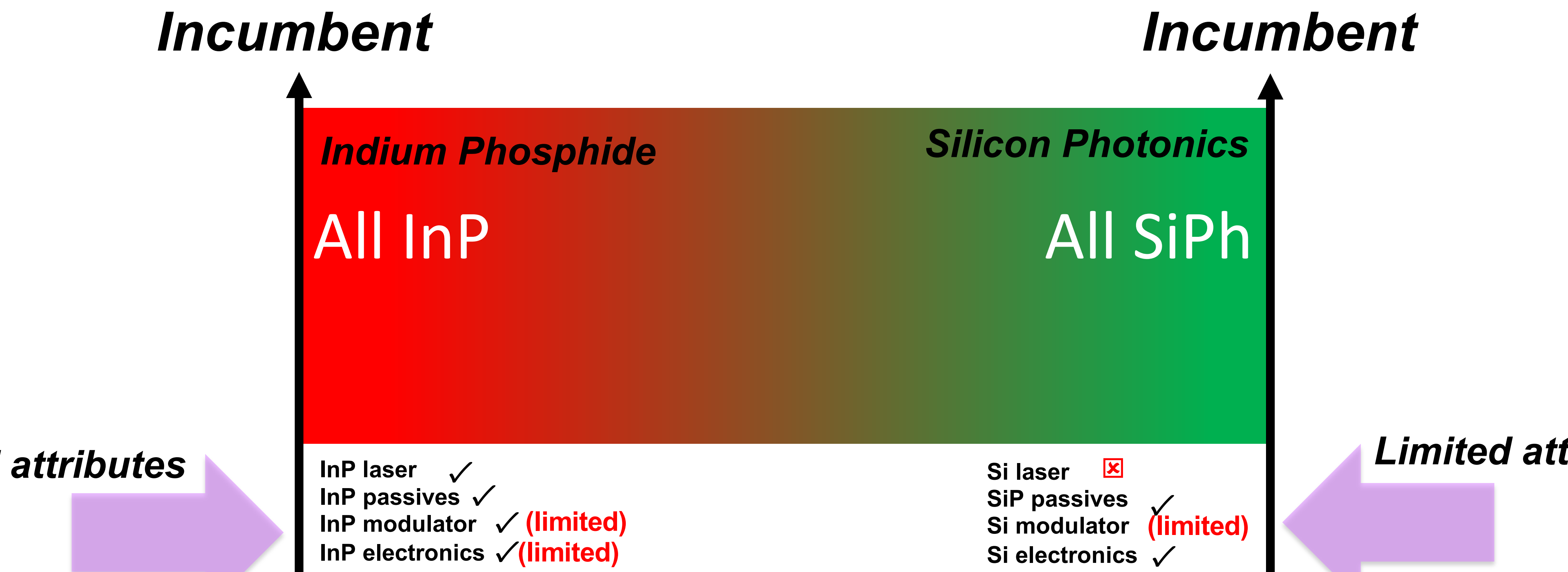
- Growth of Silicon photonics
- Trend towards hybrid platforms for PICs
- What combinations of technology make sense for hybrid PICs?



Challenge is to further PIC performance with other materials → hybrid PICs

Sources: Yole

Industry has 2 incumbent PICs…



Incumbent technologies can't do everything…need help from hybrid PIC technologies…

Hybrid PICs increase performance…

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New hybrid PICs

Incumbent | *Incumbent*

Indium Phosphide | *Silicon Photonics*

All InP | *Hybrid PICs* | All SiPh

Polymer, dielectrics
Additive to SiPh or InP

InP	Hybrid	SiPh
InP laser ✓	Dielectric AWGs etc (high performance)	Si laser ☒
InP passives ✓		SiP passives ✓
InP modulator ✓ (limited)	Polymer modulator (fast, low power)	Si modulator (limited)
InP electronics ✓ (limited)		Si electronics ✓

Limited attributes | *Limited attributes*

Hybrid PICs can boost performance of PICs