

Display Requirements for Mobile Information Terminals

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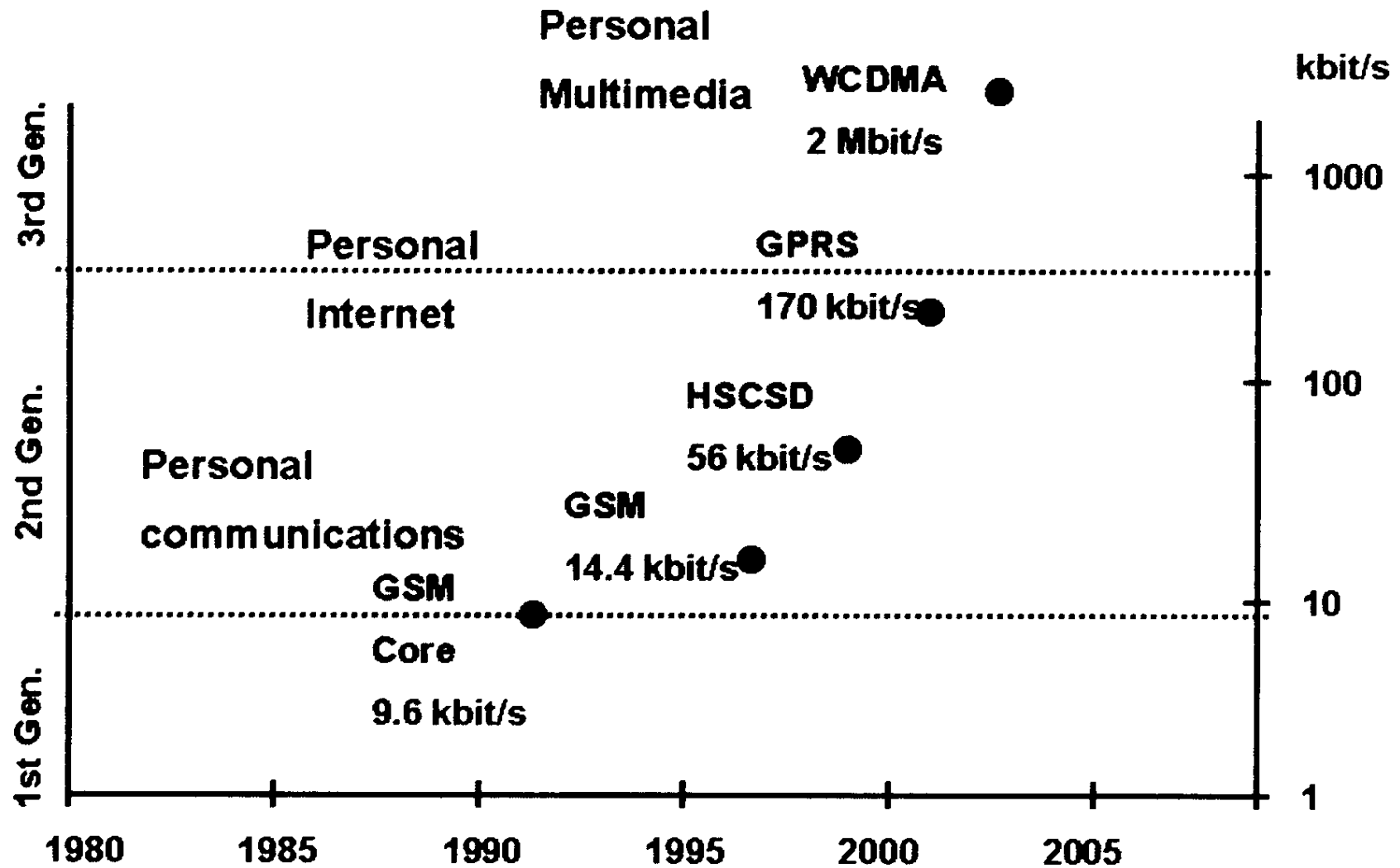
Outline

- Evolution of wireless technologies and their bandwidths
- Applications and display contents
- Luminous environment and auxiliary lightning
- Product design and UI hardware
- Physical requirements
- Conclusion: Which display technology?

Evolution of mobile telephony (1)

- First generation (1G, 1988~1995), e.g. AMPS, NMT. Analogue.
 - Limited coverage and capacity. Experimental text services
- Second generation (2G, 1994~), e.g. GSM, DAMPS, PDC, CMDAOne
 - Digital network and terminals
 - Extended coverage, capacity, roaming
 - SMS standard, internet browsing, simple graphics
- Transitional generation (2.5G, 2000~), e.g. GPRS, PHS, EDGE, HSCSD
 - Multiple GSM channels
 - High-speed circuit switched data
- Third generation (3G, 2001~), DS-CDMA, MC-CDMA, UTRA TDD
 - All-IP (by 2005), 2 Mbps
 - Enhanced security
 - Efficient channel allocation, smaller cells, location information

Evolution of mobile telephony (2)



Other high-bandwidth wireless infrastructures

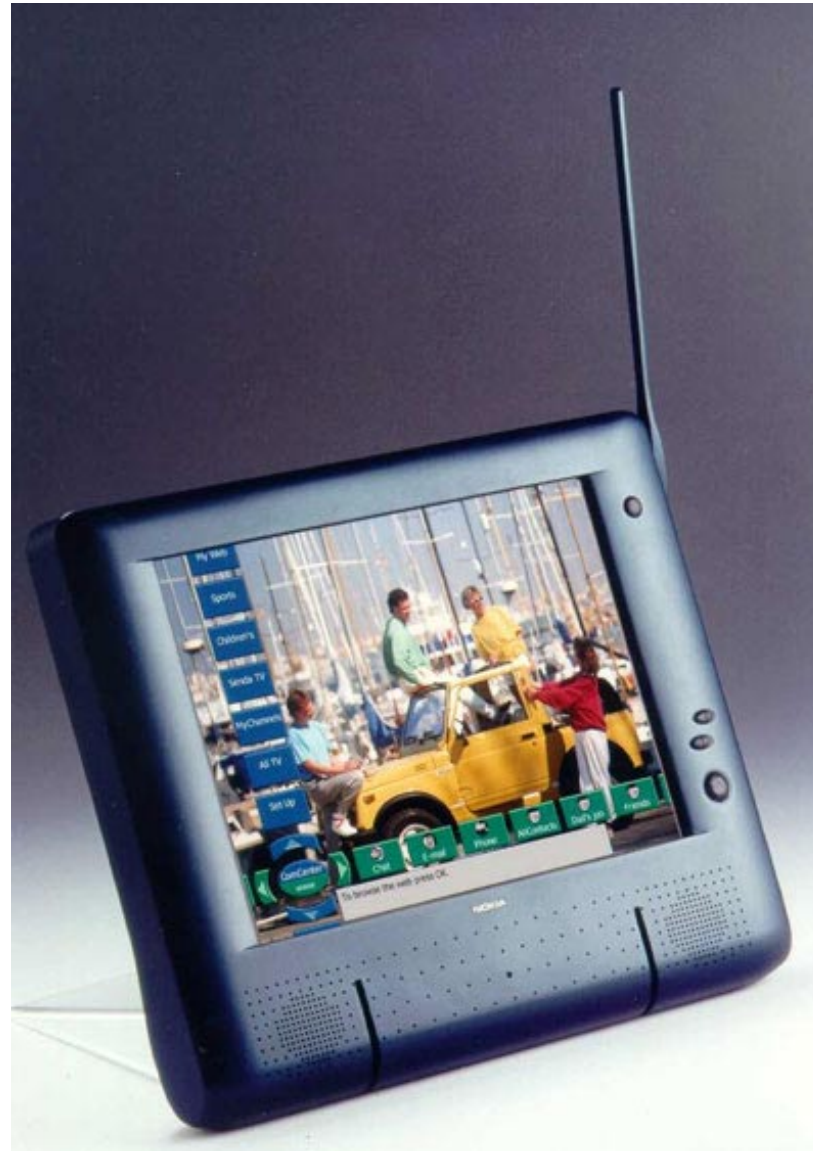
- Wireless local area network (WLAN)
- BlueTooth (BT)
- Terrestrial Digital Video Broadcasting (DVB-T)
- Satellite Digital Video Broadcasting (DVB-S)
- Packet Radio
- Global Positioning System (GPS)

All-IP Applications

- Voice
- Video on Demand
- Pay per View
- Interactive gaming
- Video-conferencing
- Real-time broadcast TV
- Interactive TV
- Streamed audio

Display-centric devices (1)

DVB-T terminal
prototype
Shown at
Internationale
Funkausstellung
(IFA), Berlin,
August 1999.
Display size:
12" diagonal



Display-centric devices (2)



Nokia Communicator 9210. Display size: 40x128 mm

Bandwidth and still images

Technology	Bitrate (Mbps)	Colour depth (bits) @ 200 PPI	Resolution (PPI) @ 24-bit colour
1G	-	-	-
2G	0.0096	<1 (16 s @ 1 bit)	10
2.5G	0.384	2.5	64
3G	2	13.2	148
BlueTooth	0.7	4.5	87
WLAN	10	66	332
DVB-T	31.7(@8 MHz)	209	591

Assumptions: 1 sec download, 50% compression, Communicator display size, full bandwidth

Bandwidth and moving images

Technology	Bitrate (Mbps)	Pixel count	Colour depth (bits)
1G	-	-	-
2G	0.0096	-	-
2.5G	0.384	QCIF (176x144)	8-10
3G	2	QCIF~CIF	12-15
BlueTooth	0.7	QVGA-VGA	10-12
WLAN	10	VGA	18-24
DVB-T	31.7(@8 MHz)	HDTV	18-24

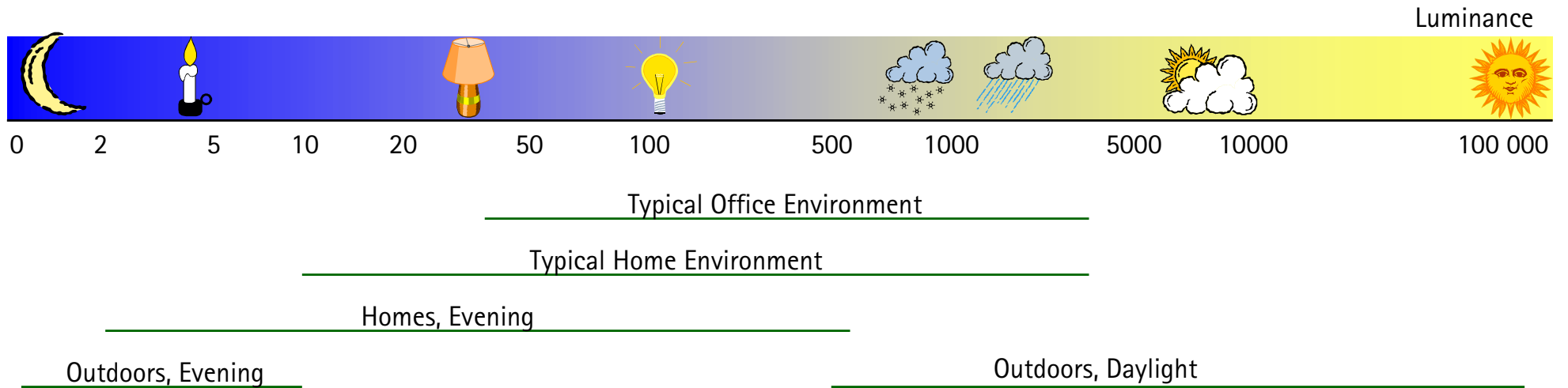
Applications and Display Requirements (1)

- Games
 - Low resolution, cost
 - Moderate colour depth and response speed
 - Normally black
- Positioning services
 - High resolution, reflectivity, contrast
 - Moderate colour depth. Slow response OK.
 - Normally white
- Imaging phones
 - Large colour depth and wide gamut
 - High contrast, medium resolution
 - Normally black

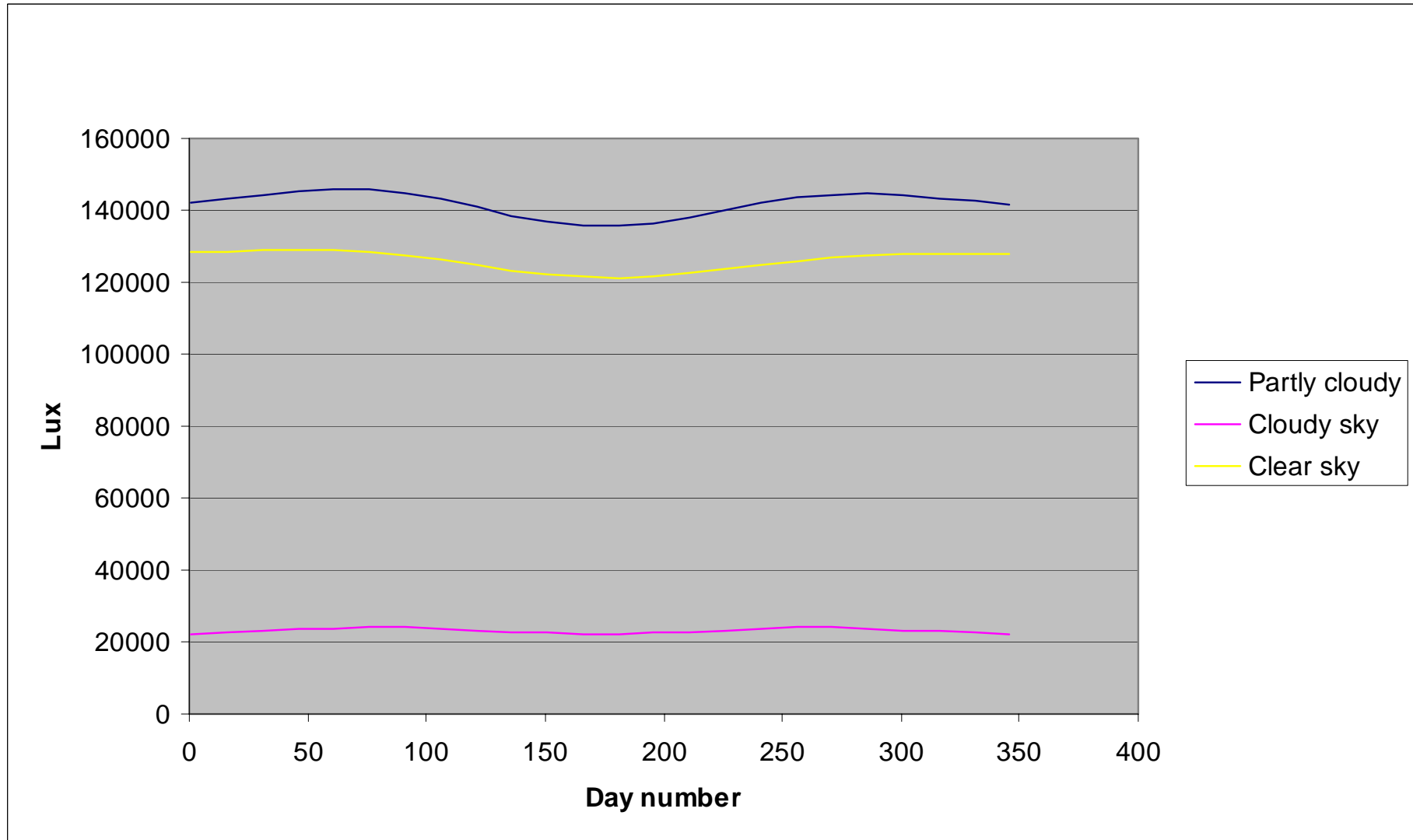
Applications and Display Requirements (2)

- Soft copy reading
 - High resolution
 - Paper-like whiteness
 - Bistability, normally white
- Mobile Video Telephony
 - Moderate colour depth
 - Low resolution, normally black
 - Fast response
- Mobile TV reception
 - Moderate resolution
 - Wide gamut, large colour depth, normally black
 - Fast response
 - High contrast

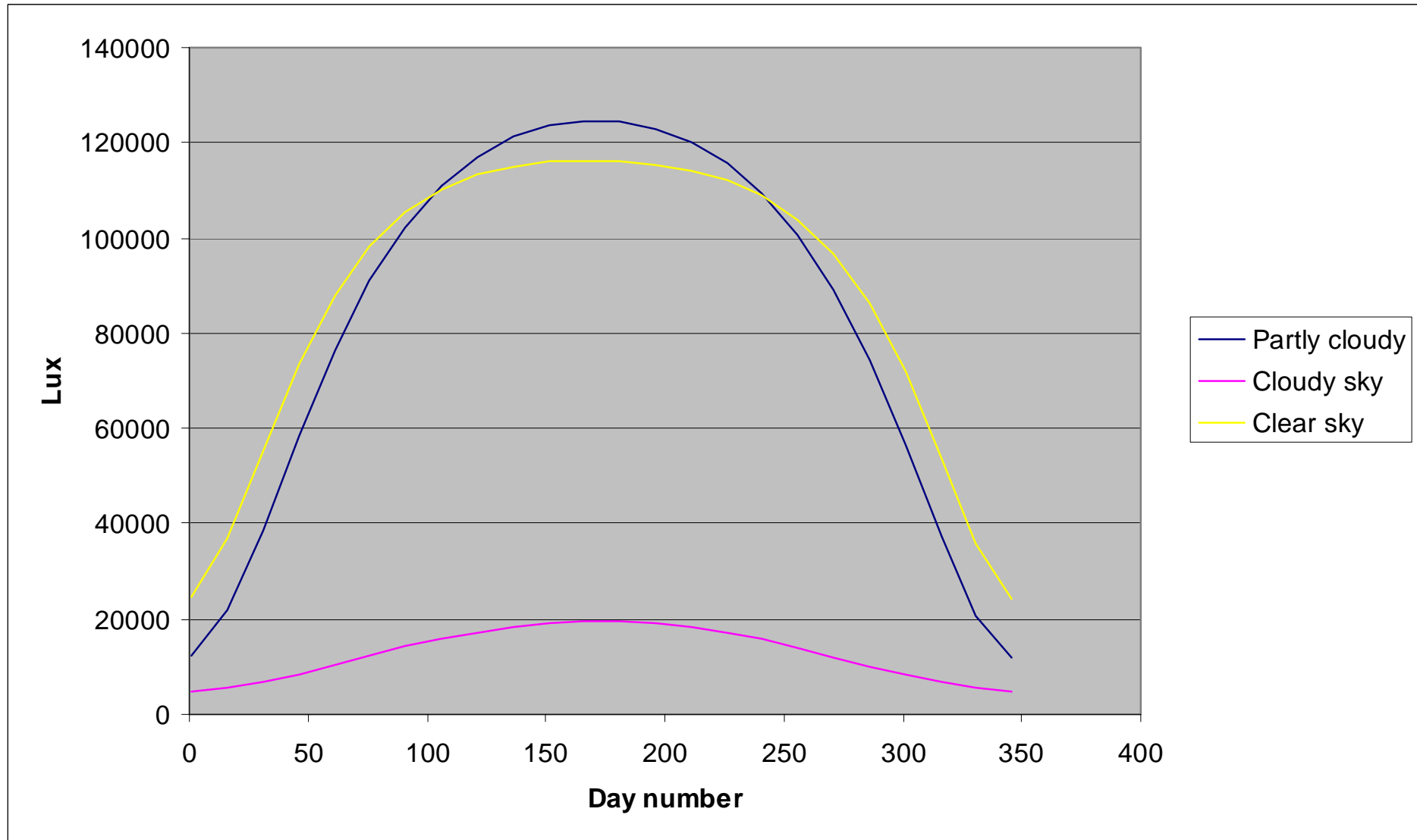
Luminous environment (1)



Illumination at horizontal plane (0° N)



Illumination at horizontal plane (65° N)

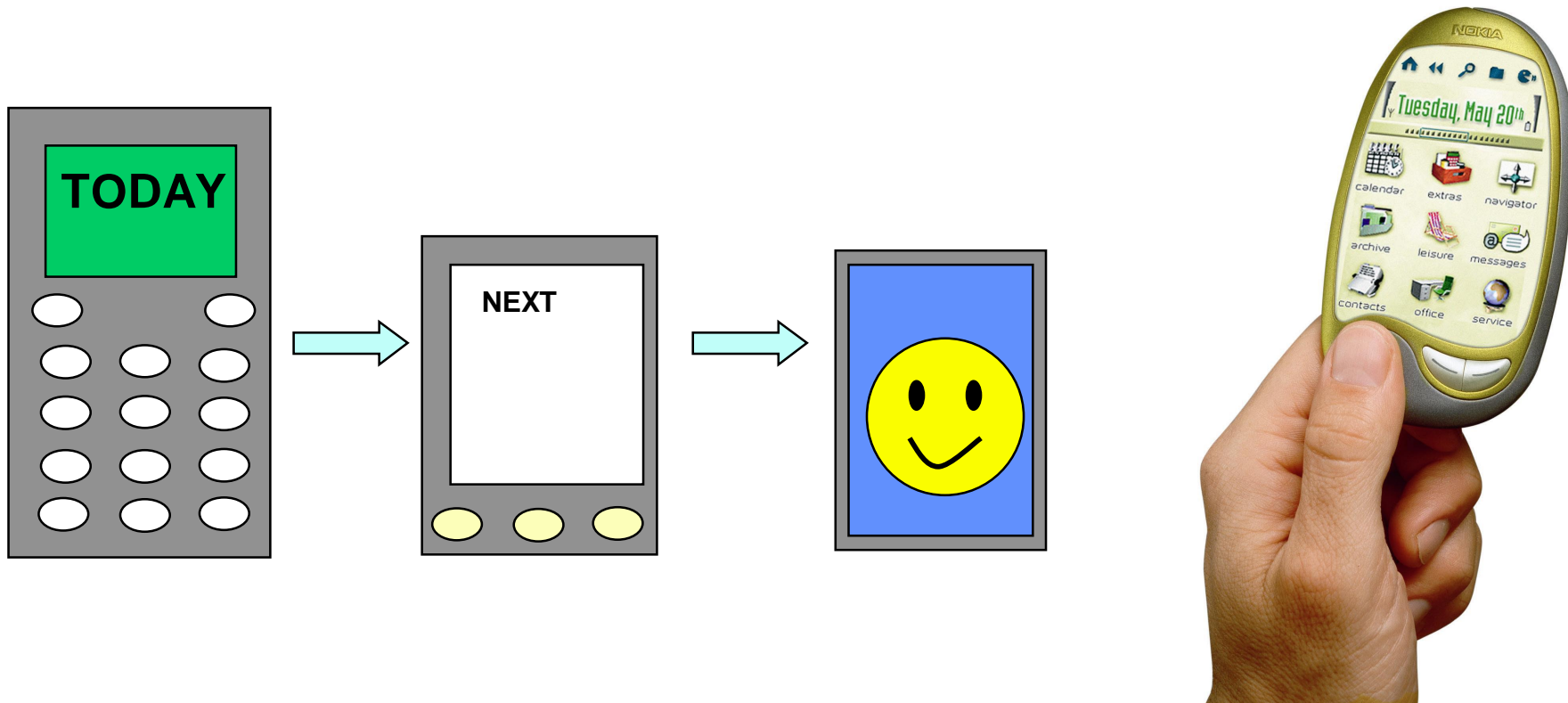


Ubiquitous terminals and illumination

- Extremely bright emissive or transmissive displays
- Transflective displays good compromise but expensive
- Even paper-like reflective displays need auxiliary lighting
- Issues of auxiliary lighting
 - Parallax
 - Scattering
 - Colourisation
 - High resolution display interference or moiré

Increased relative footprint

- Information-rich multimedia on small displays a challenge
- Small-footprint displays integrated with case
- HMD or microdisplay possible but ergonomics an issue



Physical display requirements

- Wide temperature range: -30 -- +70 deg C.
- 1 m drop test : call for plastic substrates
- Non-toxicity
- UV degradation
- Sealing for dusty environments

Conclusion: Which Display Technology?

- Phone bandwidth limits response speed and colour depth requirements
- Wireless broadband infrastructures require high-end displays
- Display requirements vary by region, market, and application
- No "ultimate" display technology
- Product diversification by design display choice
- Bright emissive or transmissive display best but high power.
Will high-efficiency OLEDs solve this?
- Transflective displays good compromise but colour adjustment needed
- Common requirements:
 - Rugged, low cost, low power, design-friendly