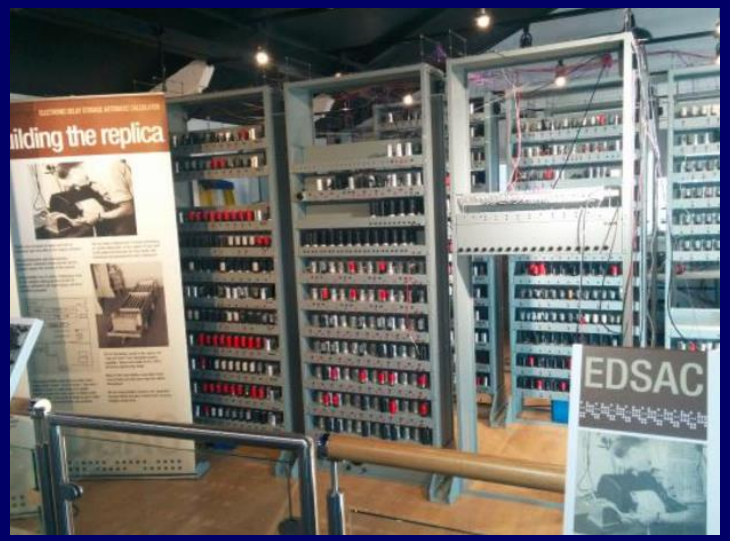
# Traditional system validation methodology will not work for connected-car
## - Learn from the computer history -

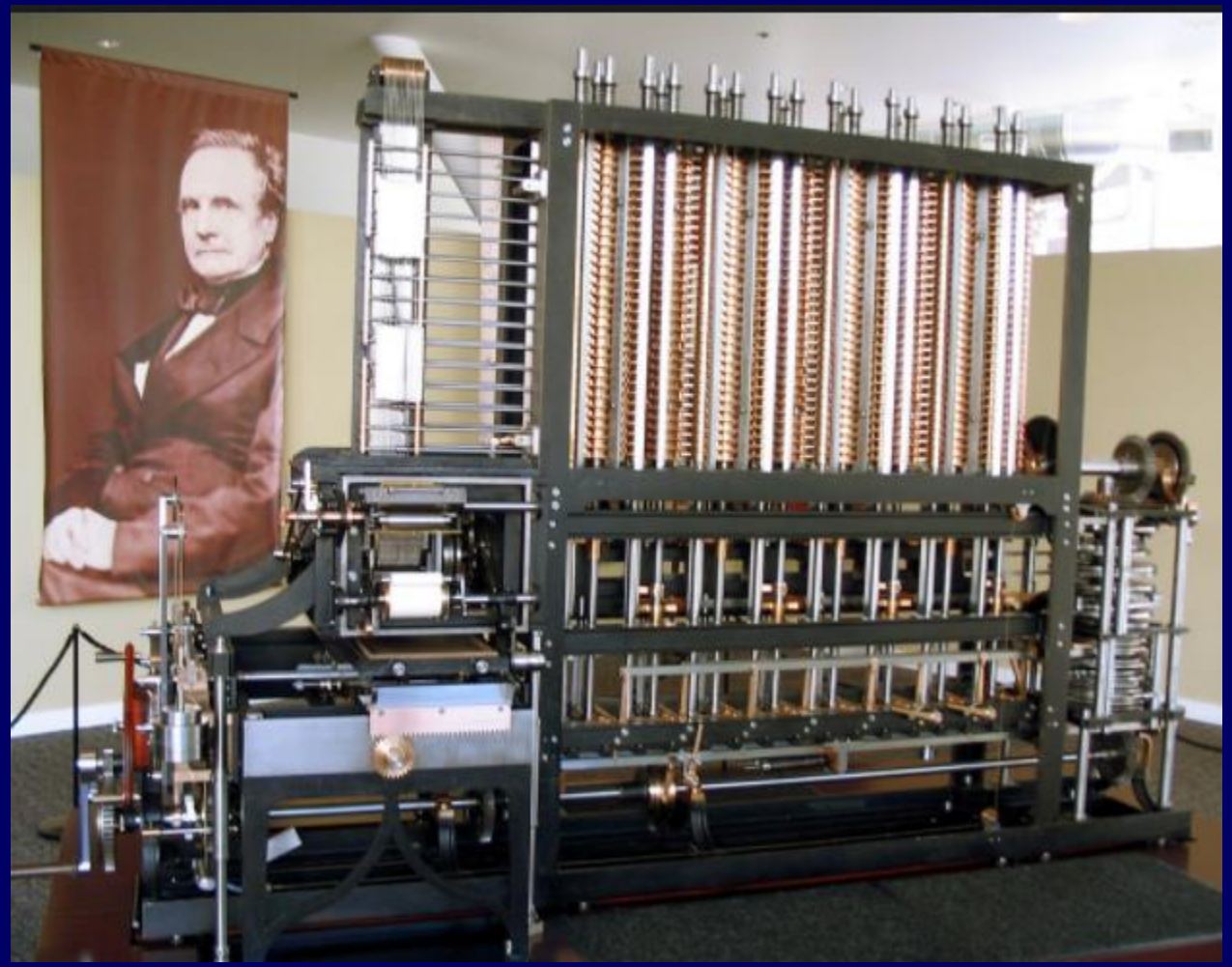
Hisao Munakata

Linux Foundaton, board member
Automotive Grade Linux, Advisory board
Senior Director, Renesas Electronics Corp

# Computer history


100% mechanical



ENIAC (1946) : World first well-known “computer”

EDSAC (1949) : World first computer that runs **“program (software)”**

# Computer used to come with dedicated software

HITACHI
HITAC M280H
(1983)

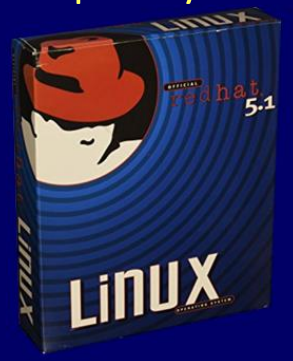

DEC
MicroVAX2
(1985)


SUN SS4
(1997)

SUN 4C/50
(2000)



3rd party OS



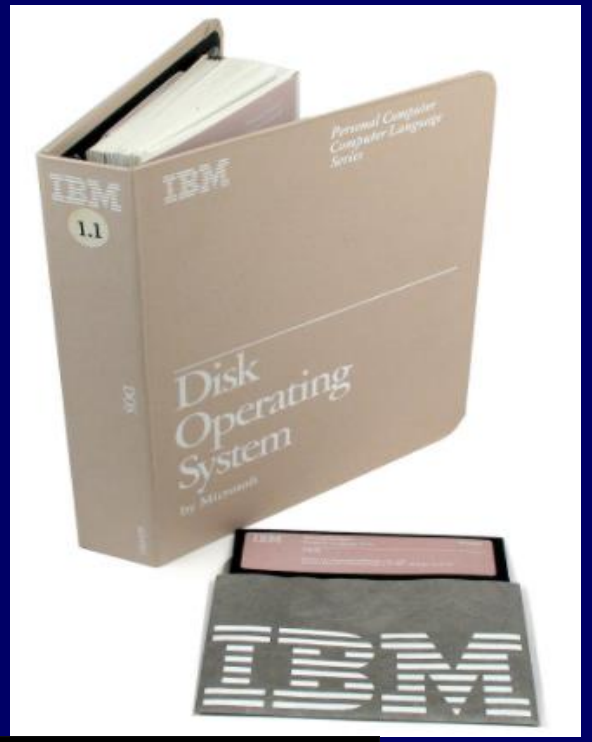

1991 Linux development 1998

for Sparc4c

# Personal computer (early days)

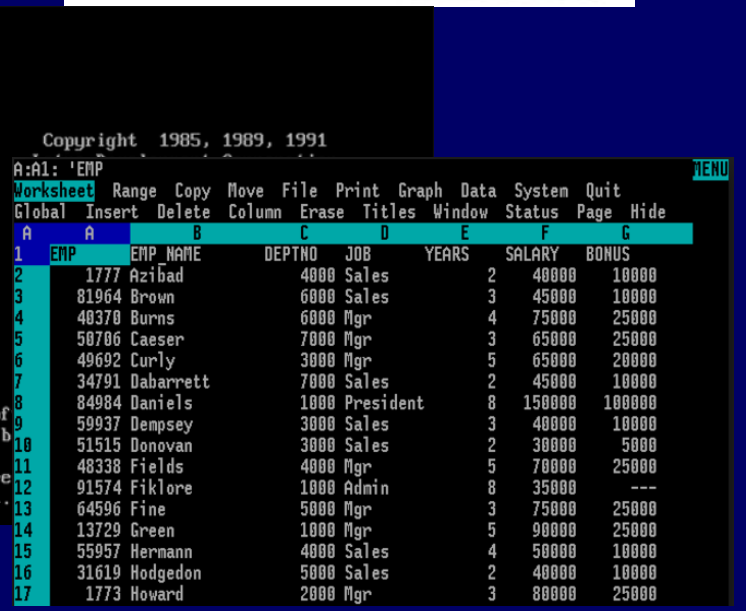

IBM PC-AT (1984)

IBM provided PC-DOS

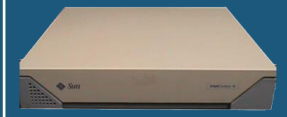



PC manufacturer can validate whole system integration. (HW+CPU+OS+APP)


Limited application



# Computer world eco-system model trends

| | EDSAC | mainframe | minicom | IBM PC-AT | workstation (UNIX based) | WNTEL PC | workstation (Linux based) |
|---|---|---|---|---|---|---|---|
| |  |  |  |  |  |  |  |
| date | 1950 | 1970 | 1980 | 1985 | 1995 | 1995 | 2000 |
| CPU | All in one solution<br><br>HW vendor can validate operation as a whole system (simplified use case) | | | CPU provider | | | |
| Board | | | | HW vendor provide OS | | HW vendor | |
| OS | | | | | | OS vendor | |
| App SW | | | | limited 3rd party App → various | | | ISV |

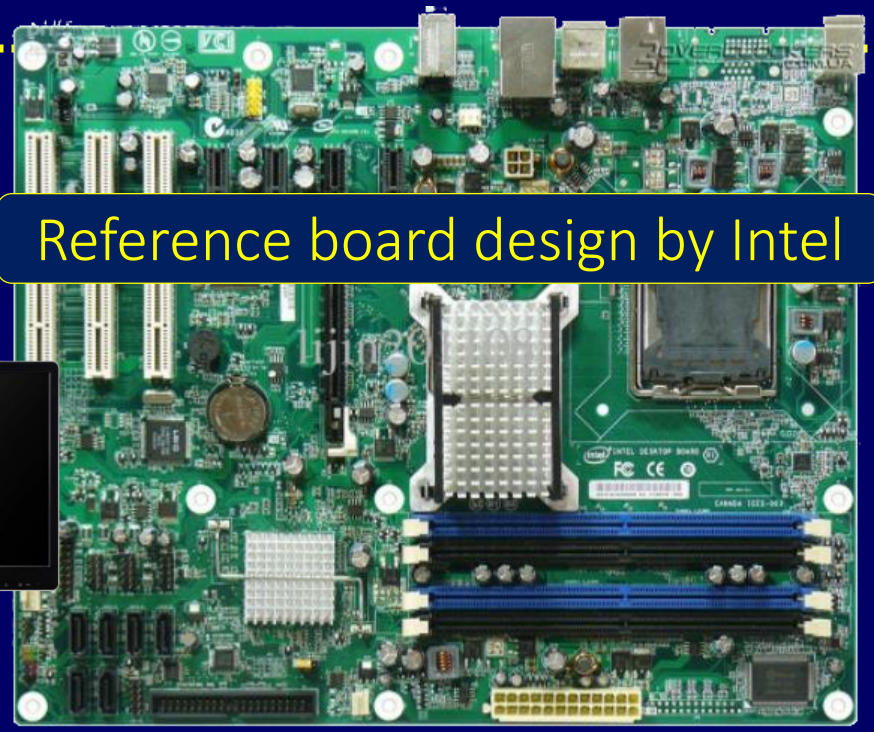
# Personal computer (WINTEL model)

Windows 3.1 1990


CPU verification **based on OS behavior**

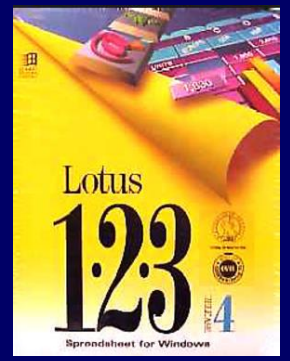

WINTEL scheme worked well

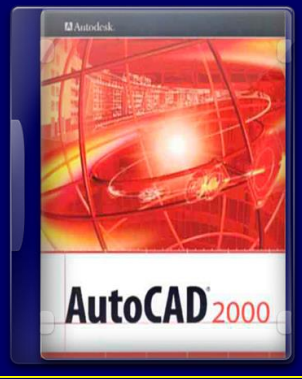
IHV

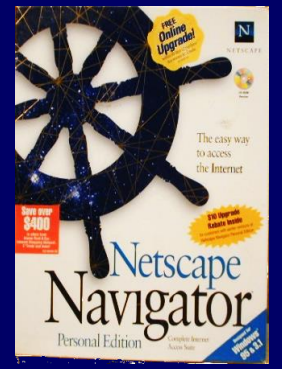


Reference board design by Intel

ISV




3rd party peripherals

3rd party application SW

# Current IVI system development model

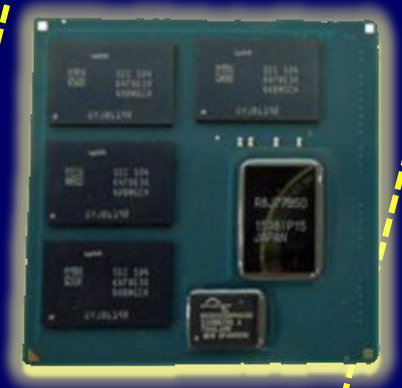
HMI and most of IVI applications are privately developed by each tier1

system board

IVI Application SW

Tier1 supplier

SOC



SOC vendor provides base Linux BSP

- media player
- map
- voice control
- connectivity

3rd party Middleware components

OS
Linux BSP

yocto PROJECT

like WINTEL model, but as a free delivery (not fully validated)

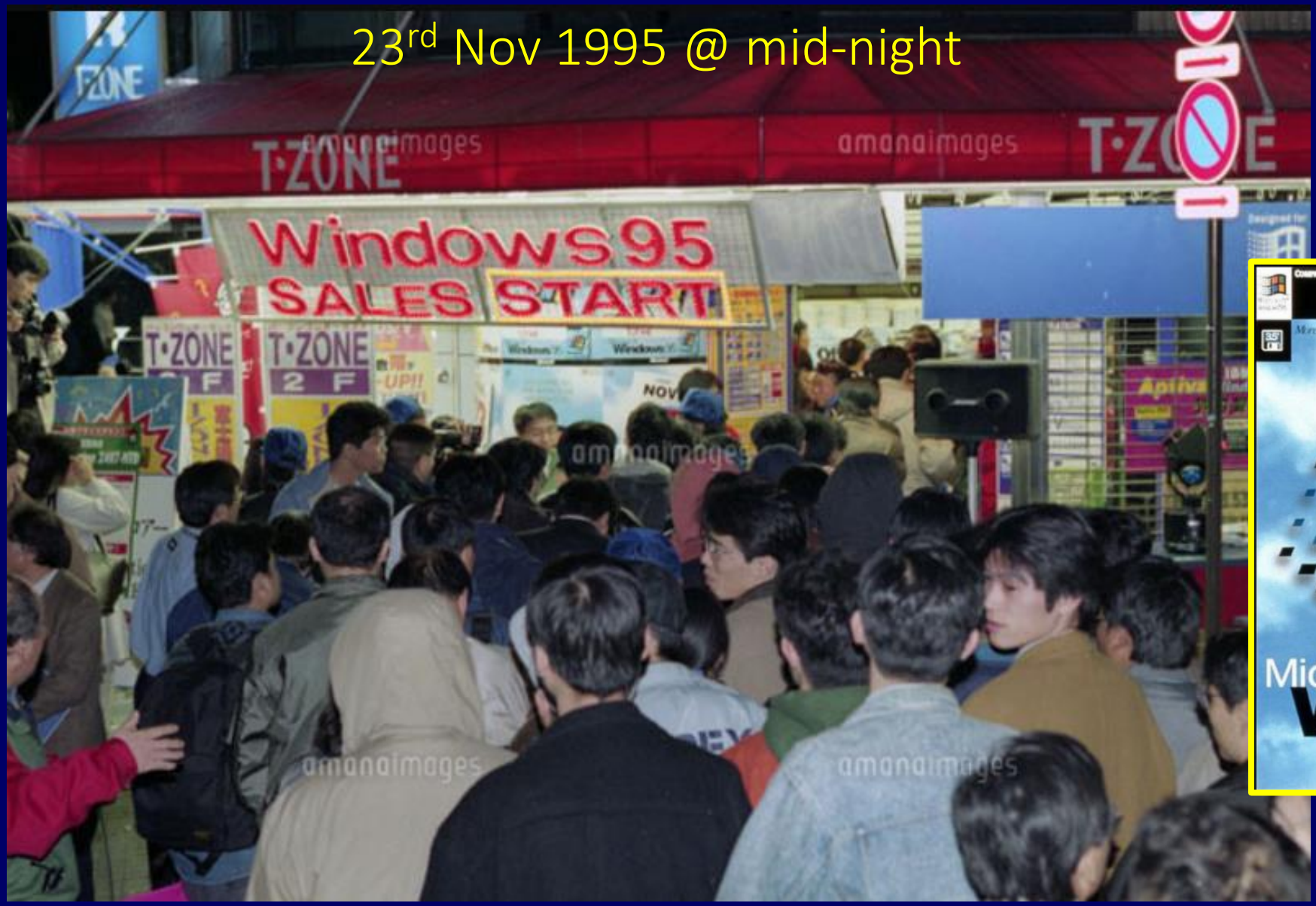
# Projection of current IVI system (≈ IT SW state of 20 years ago)

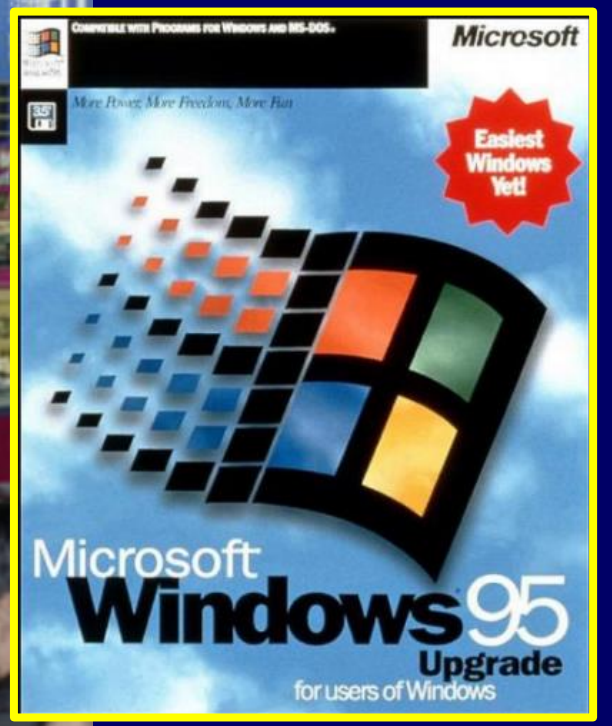
IVI @ 2015～

limited ISV

| | EDSAC | mainframe | minicom | IBM PC-AT | wor (UNI | PC | workstation (Linux based) |
|---|---|---|---|---|---|---|---|
| |  |  |  |  |  | |  |
| date | 1950 | 1970 | 1980 | 1985 | 1995 | 1995 | 2000 |
| CPU | All in one solution<br><br>HW vendor can validate operation as a whole system (use case are limited) | | | CPU provider | | | |
| Board | | | | HW vendor provide OS | | HW vendor | |
| OS | | | | | | OS vendor | |
| App SW | | | | limited 3rd party App → various ISV | | | |

# 1995 = people start using “connected computer”



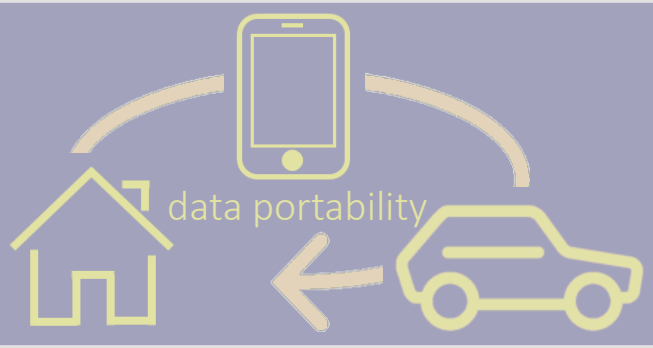
# What IT&PC industry experienced after 1995

- Internet connection (from Win95)
- Spam, Computer virus (serious after Internet connection)
- Software update [e.g. Windows Update] (from Win95)
- Portable music player [e.g. iPod] (from 2001)
- Virtualization (Xen 2003, KVM 2006)
- Cloud (e.g. On-line storage use from 2006)
- Smartphone data portability (from 2007)
- Web application [e.g. Office365] (from 2011)


All those technologies are coming to the automotive right now !

connected | car hacking | OTA update | Smartphone connection | Virtualization

# SW provider eco-system model category

| | Generation I | Generation II | Generation III |
|---|---|---|---|
| Target |  |  |  |
| | Old age computer<br>Traditional embedded | PC | could IT service<br>connected car |
| condition | All-in-one delivery | IHV + ISV |  |
| HW | Fixed | Fixed | undetermined |
| SW | Fixed | undetermined | undetermined |
| Validation | Standalone Test | Certification | Standardization |

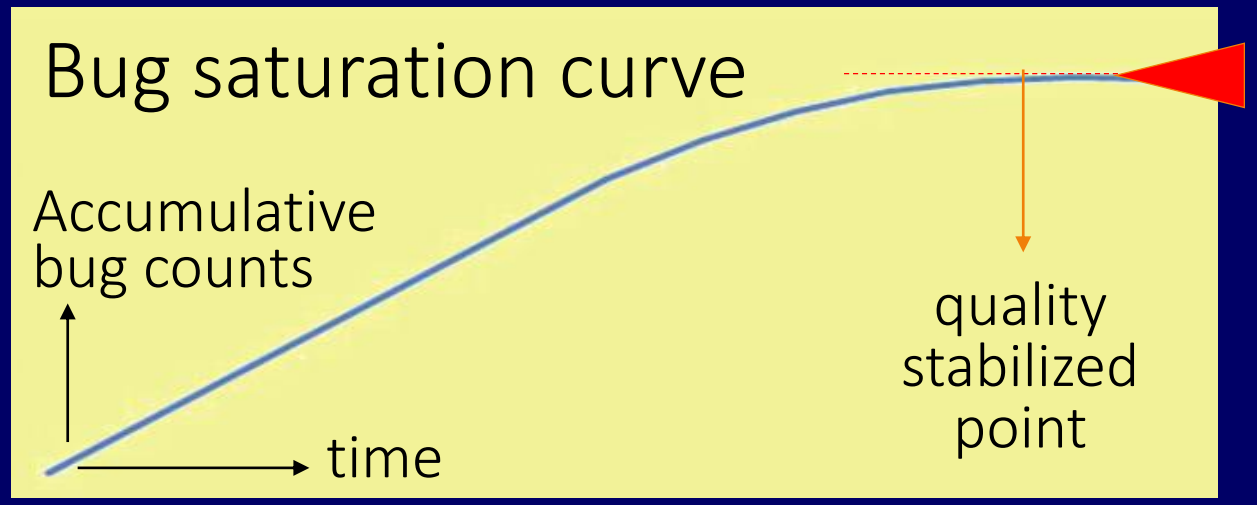
# “Generation I” : validation for all-in-one system

**Assumption**

- Spec defines all use case combination
- You have enough insight for the code

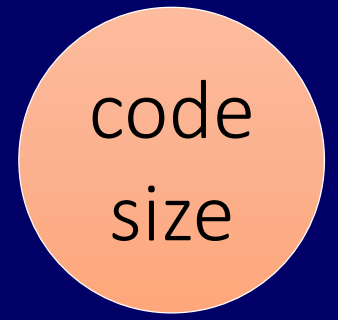
$$\text{Quality} = \frac{\text{Pass count}}{\text{All test case}}$$

Quality can indicate by the test coverage.

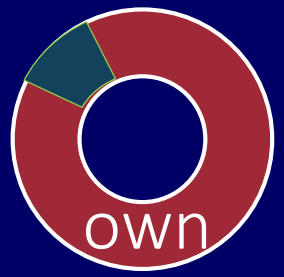



**problem one**

program code size is bloating



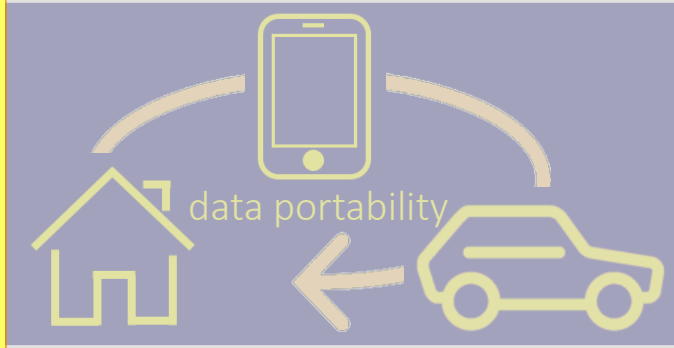

**problem two**




Code visibility become low


“Generation I” method no more applicable to IVI due to the complexity and low visibility

# SW provider eco-system model category

| | Generation I | Generation II | Generation III |
|---|---|---|---|
| Target |  |  |  |
| | Old age computer<br>Traditional embedded | PC | could IT service<br>connected car |
| condition | All-in-one delivery | IHV + ISV | |
| HW | Fixed | Fixed | undetermined |
| SW | Fixed | undetermined | undetermined |
| Validation | Standalone Test | Certification | Standardization |

# “Generation II” : Compatibility by the certification

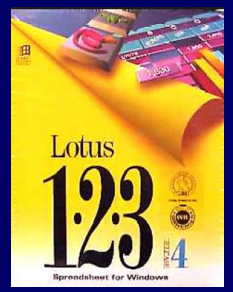

IHV

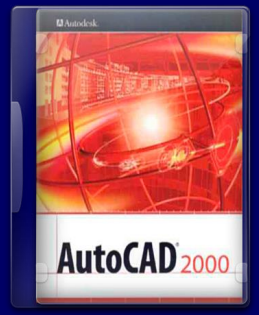
hardware interface = industry standards
( USB, PCI, memory BUS, display interface )

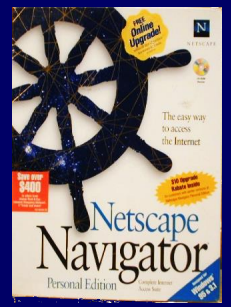
relatively clear

Compatibility Specification for 3rd party

very complex




ISV

external software API definition
( vendor specific, include inter-app. coordination )

# IHV HW Compatibility certification

Microsoft WinHEC 2006

## Windows Vista Logos


## Windows Logo Qualification Changes

- Two Windows Logo qualification levels are available in general for all Window Vista devices
  - 1) Premium – Storage currently has no premium logo programs
    - Hybrid Storage is required for Premium System Windows Logo in June 2007
  - 2) Standard
- Only one qualification level is available for Windows XP and Windows Server 2003
  - Standard
- Unclassified Signature Program is available for devices which have no logo program for Windows XP, Windows Vista, and Windows Server 2003

HW equipment certification mechanism worked for IHV

# ISV SW Compatibility is more challenge

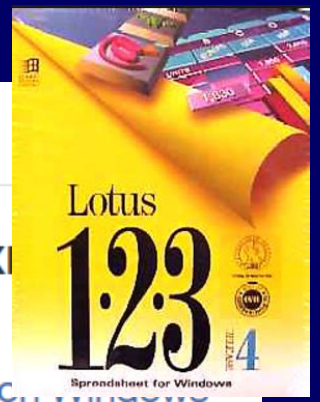
**IBM Support**

**Lotus 1-2-3 and Microsoft Windows XI**

Slow performance running 1-2-3 Script c... Windows 2000 and XP (#1086798)

"Error: 1402. could not create key..." installing 1-2-3 on Windows XP (#1088170)

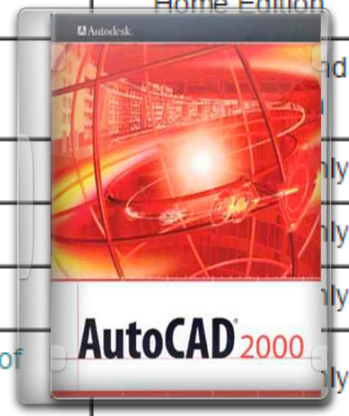
Error: "123W.EXE has generated errors" when opening (#1088872)




http://www-01.ibm.com/support/docview.wss?uid=swg27006485

**8. Which Autodesk products are compatible with Windows XP?**

| Compatibility Matrix | | |
|---|---|---|
| **Autodesk Product** | **Windows XP Compatibility** | **More Details** |
| AutoCAD® 2004 | Professional and Home Edition | Yes |
| AutoCAD LT® 2004 | Professional and Home Edition | Yes |
| AutoCAD® Mechanical 2004 | Professional and Home Edition | Yes |
| Autodesk® Architectural Desktop 2004 | Professional and Home Edition | Yes |
| Autodesk® Architectural Studio | | Yes |
| Autodesk® Building Systems | | No |
| Autodesk® Civil Design 3 | | Yes |
| Autodesk® Civil Series | | Yes |
| Autodesk Inventor™ 6 (delivered as part of Autodesk Inventor Series) | | No |
| | ional only | Yes |
| | ional only | No |

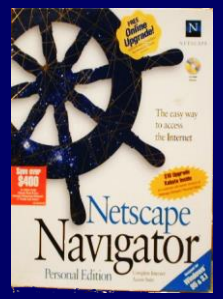


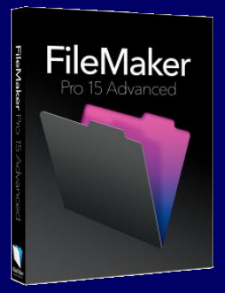

ISV struggled with quite a lot of compatibility issue (buggy)

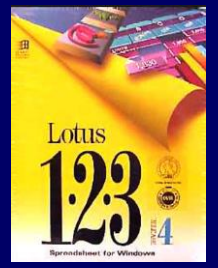
http://download.autodesk.com/us/xp_compatibility.htm

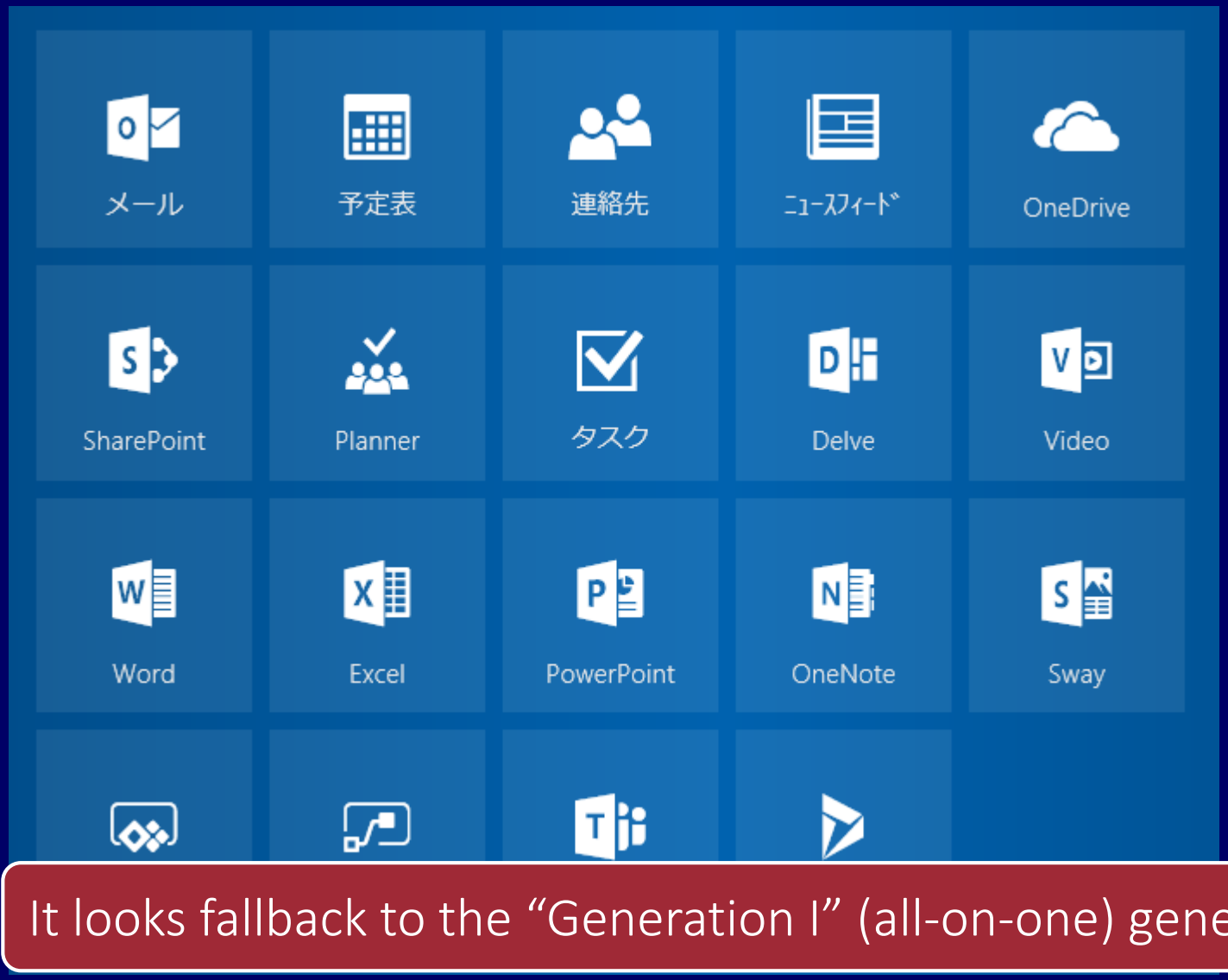
# “Microsoft Office” compensated integrity

ISV



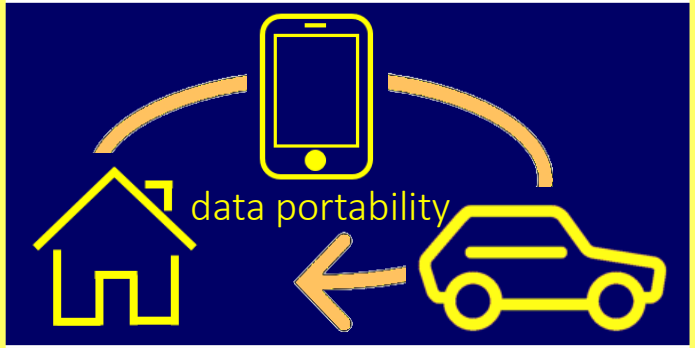




major ISV

It looks fallback to the “Generation I” (all-on-one) generation

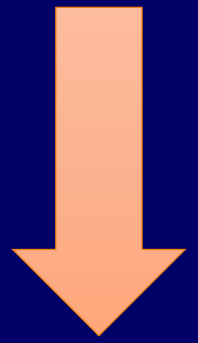
People start using Microsoft integrated application suites, and that resulted better experience

# SW provider eco-system model category

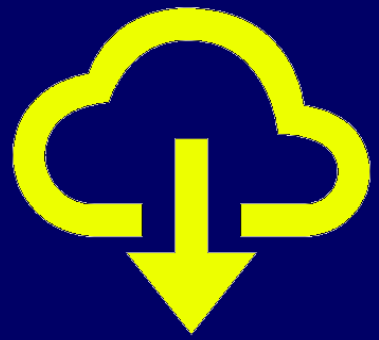
| | Generation I | Generation II | Generation III |
|---|---|---|---|
| Target |  |  |  |
| | Old age computer<br>Traditional embedded | PC | could IT service<br>connected car |
| condition | All-in-one delivery | IHV + ISV |  |
| HW | Fixed | Fixed | undetermined |
| SW | Fixed | undetermined | undetermined |
| Validation | Standalone Test | Certification | Standardization |

# “Gen. III” essentially differs from “Gen. II”

Generation II = “Equipment driven” eco-system



Digitalization by



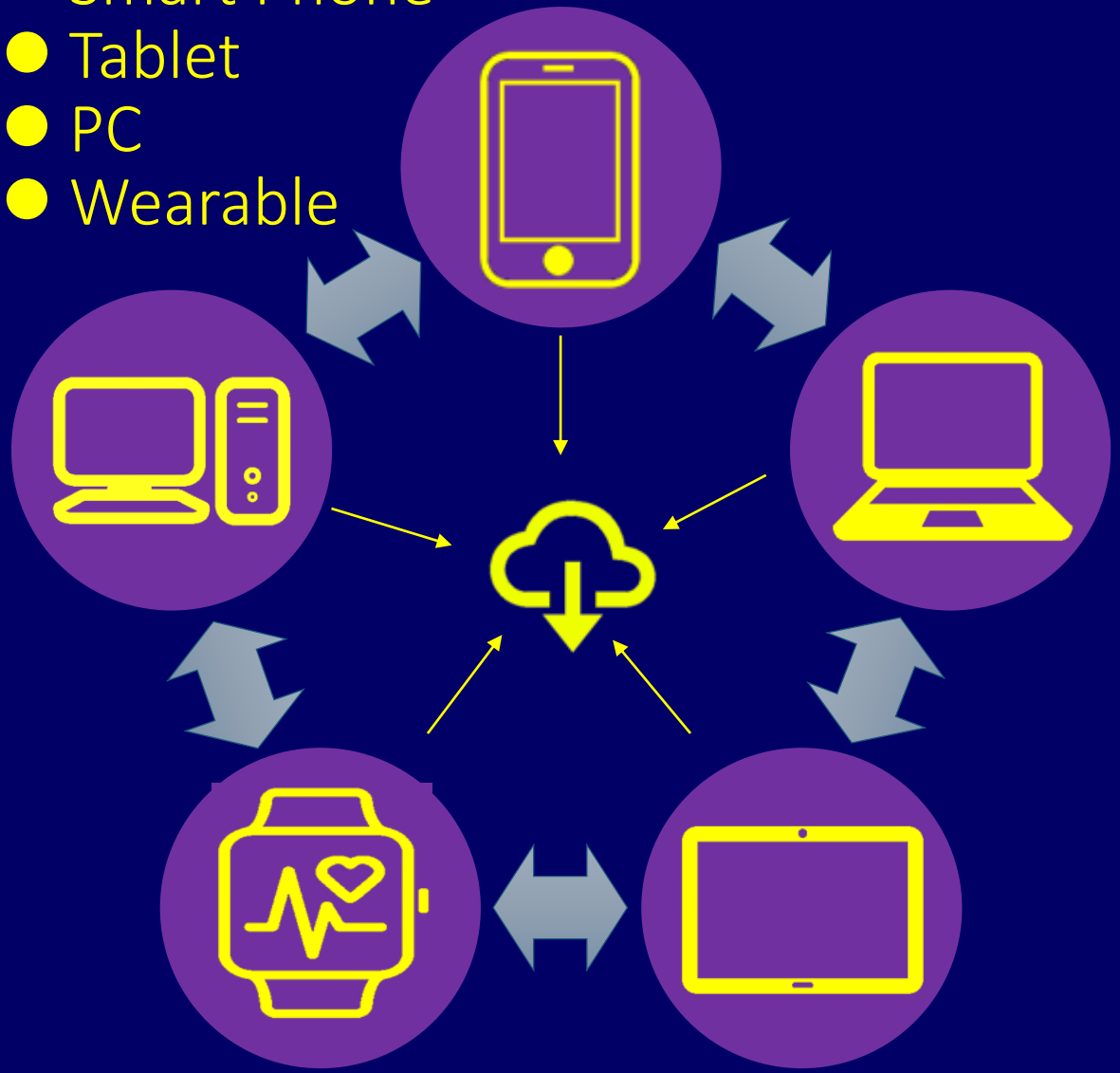
Generation III = “Data driven” eco-system

Even both requires :

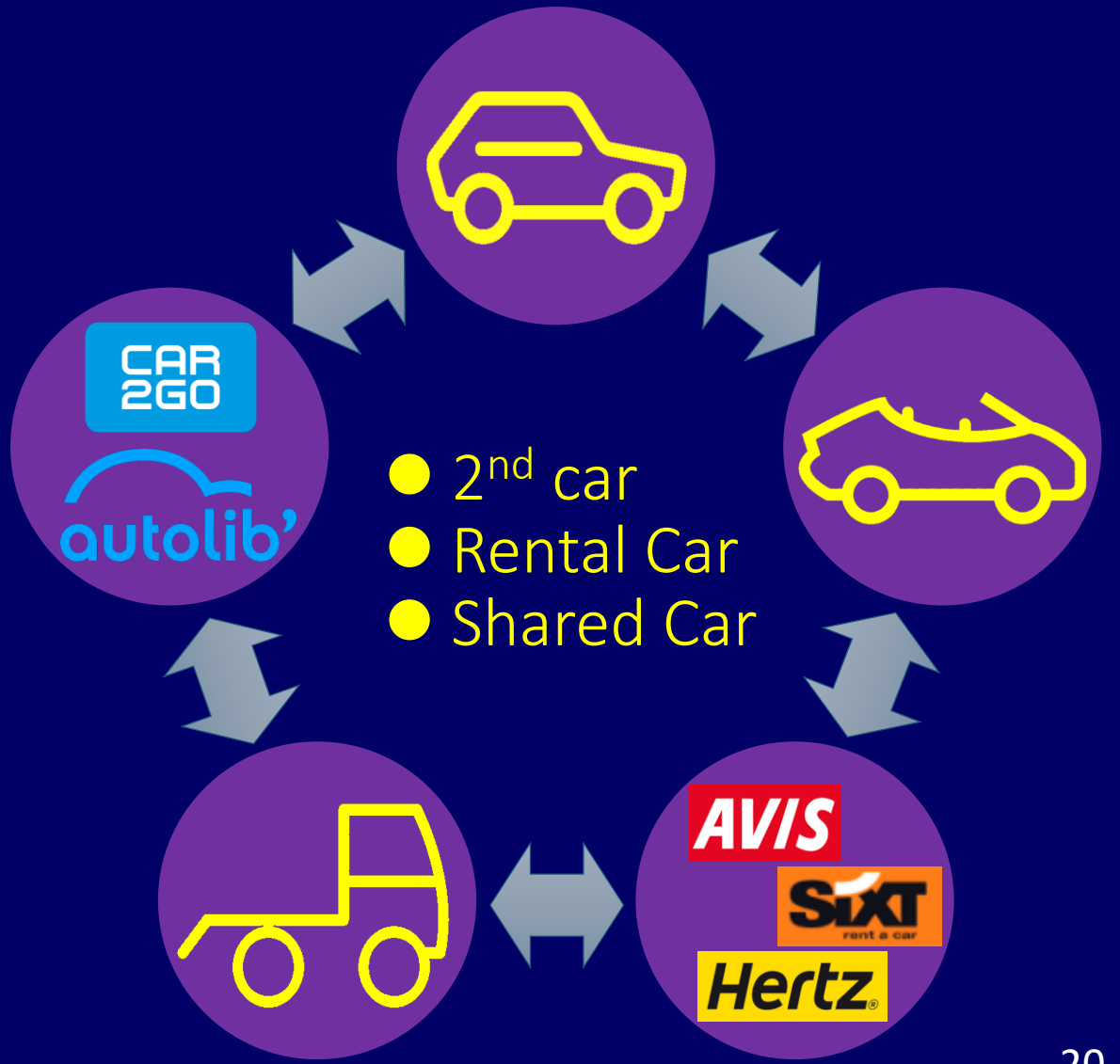
1) Industry spread eco-system creation
2) Software migration (update) after product shipment

# Automotive need to be a part of PC/IT cloud

- Smart Phone
- Tablet
- PC
- Wearable

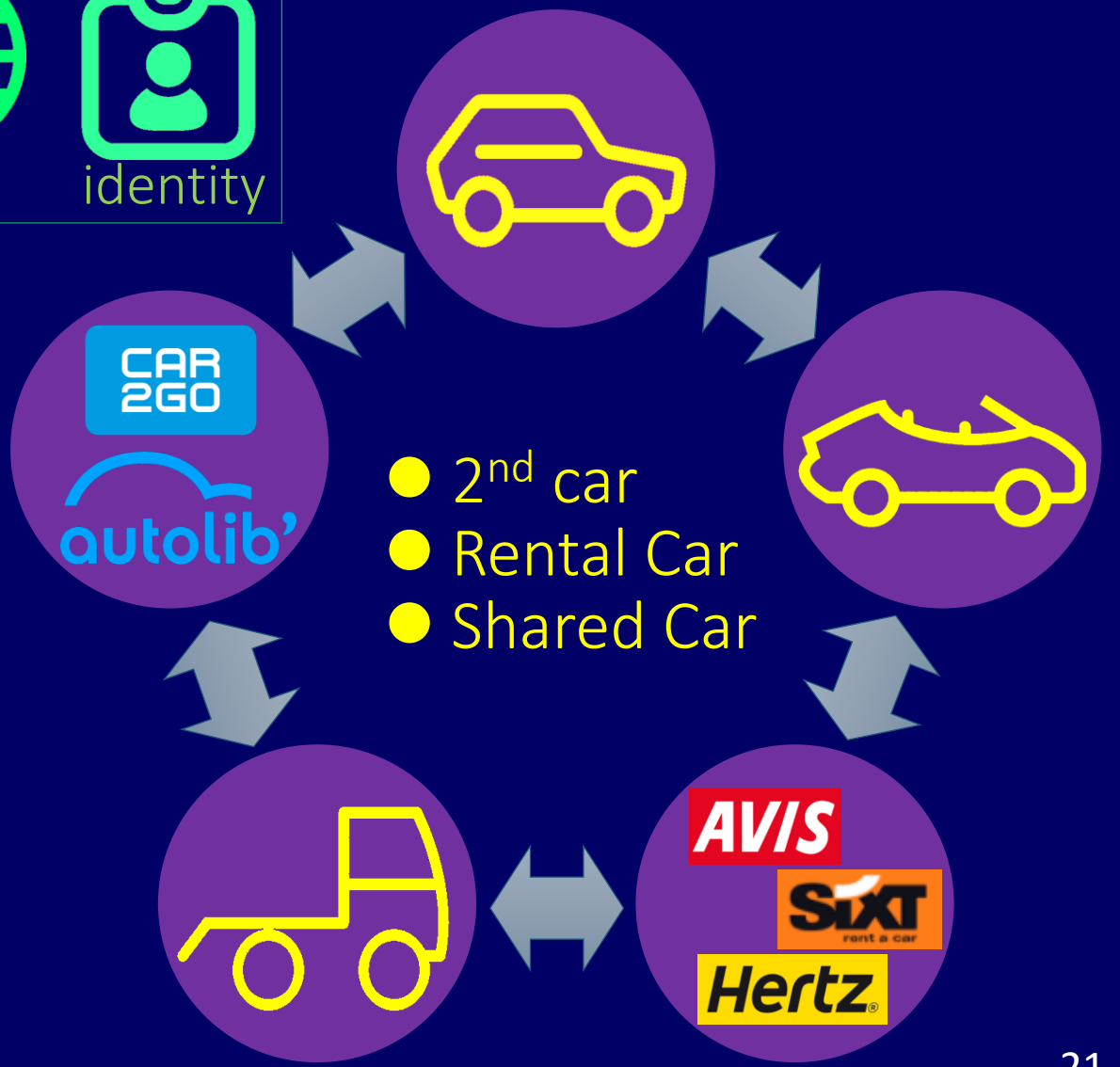


- 2nd car
- Rental Car
- Shared Car



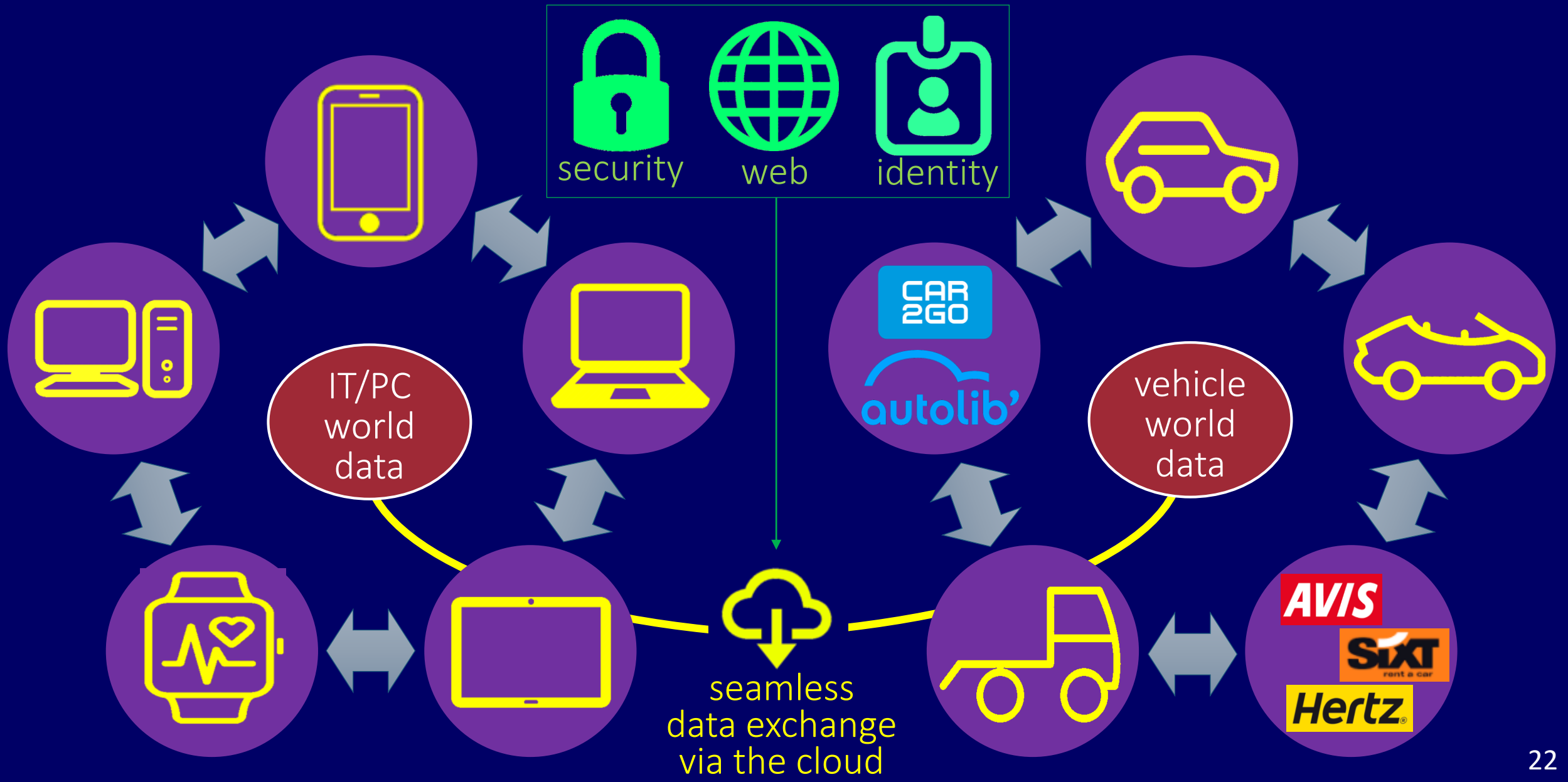
# Automotive need to be a part of PC/IT cloud

- Smart Phone
- Tablet
- PC
- Wearable


- 2nd car
- Rental Car
- Shared Car

# Automotive need to be a part of PC/IT cloud



# Gen. III eco-system realize data driven connected world

application

messaging

location

multi media

common standards

System validation on cross-industry common standards

target hardware

home (PC)

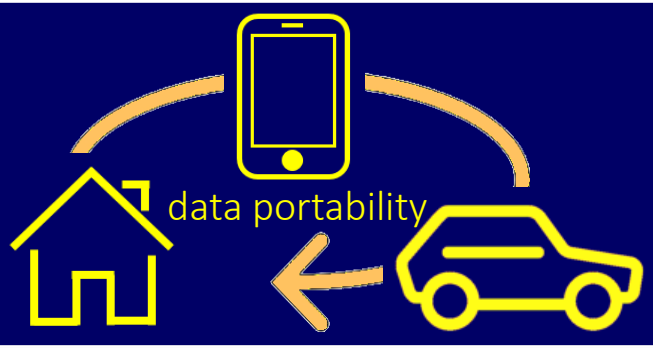
automotive

mobile

target HW specific standardization ( for “Gen. II” )



# Automotive industry should jump to “Generation III”

| | Generation I | Generation II | Generation III |
|---|---|---|---|
| Target |  |  |  |
| | Traditional embedded development model | Target Specific eco-system creation | industry-width open data exchange |
| condition | All-in-one delivery | IHV + ISV | PANDORA |

We need to manage “long-jump” to reach “Gen. III” directly from “Gen. I”.

Target

# To exceed “Gen. II”, we should learn from PC experience

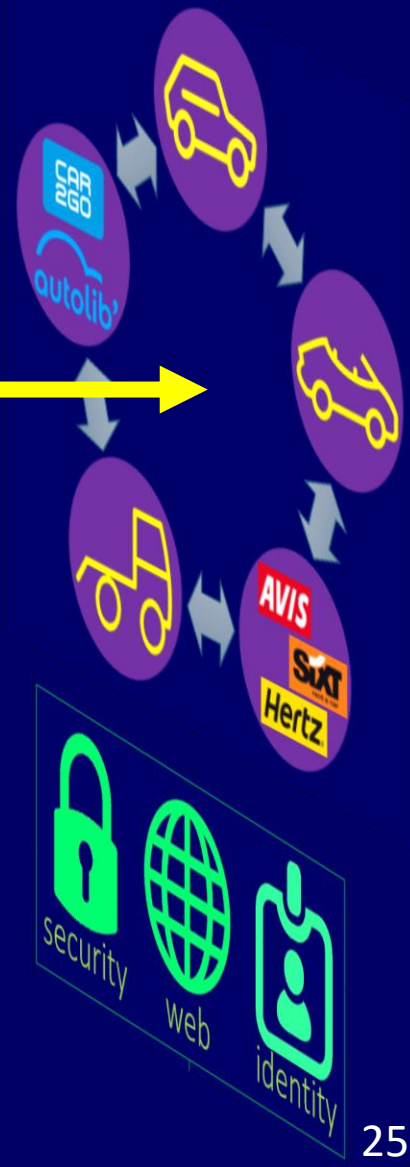
problem one

program code size is bloating → code size

problem two

own → Code visibility become low → own / others


generation II experience (IT/PC)


AUTOMOTIVE GRADE LINUX

We are lucky, as we can learn a lot from PC/IT industry member

THE LINUX FOUNDATION

# My message summary

- At home and office, people already get connected after 1995. And that waves finally reached to the vehicle environment.
- IVI system development remains in old age “All-in-one” model. To realize “connected”, we need to migrate to the “open and collaborative” industry-width eco-system.
- Traditional equipment oriented eco-system (that PC industry created) does not work for highly complicated modern system. “Data driven brand new eco-system” will solve our issues.
- We are lucky as we can learn a lot from PC/IT experience. And Linux Foundation is the perfect pace to do that.