

2G,3G,4G...

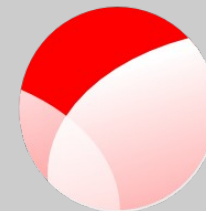
in your PC, in your phone, and everywhere



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QMI **LTE** libmbim
data-rate kernel
IoT **qmi_wwan** **MBIM** latency
ModemManager
AT Mobile Broadband **M2M**
3GPP **USB** user-space
libqmi

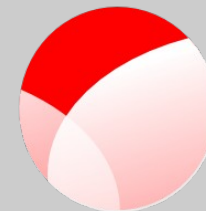
Who am I?



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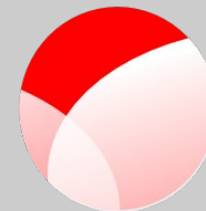
The road to LTE...



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- **2G**
 - CS **voice** calls the key feature, while PS data communications just an add-on.
- **3G**
 - Designed for both CS **voice** and **video** calls, plus PS **data** communications.
- **4G**
 - Designed only for PS **data** communications.
 - **Data-transmission specific design targets.**
 - Peak rate and rate at cell edge.
 - Low latency.
 - High capacity (spectral efficiency)
 - Spectrum flexibility.

The road to LTE: 3GPP



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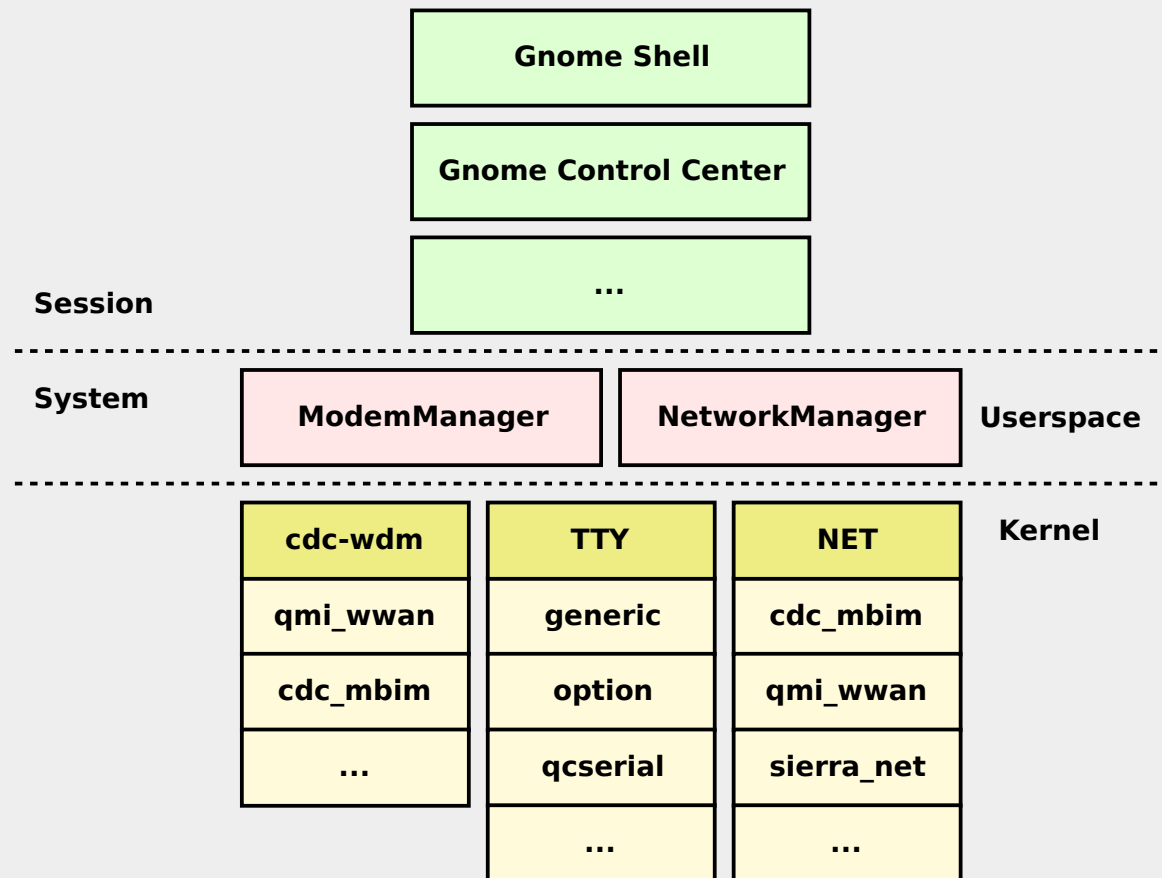
- 2G:
 - **GSM** (r96): 14.4 kbit/s
 - **GPRS** (r97): (FL) 57.6 kbit/s, (RL) 28.8 kbit/s
 - **EDGE** (r98): (FL, RL) **236.8 kbit/s**
- 3G:
 - **UMTS** (r99): (FL) 384 kbit/s [ITU: IMT-2000, true 3G]
 - **HSDPA** (r5): (FL) 14 Mbit/s
 - **HSUPA** (r6): (RL) 5.76 Mbit/s
 - **HSPA+** (r7,r8): (FL) 42 Mbit/s, (RL) 11.5 Mbit/s
 - **DC-HSDPA** (r8), **DC-HSUPA** (r9), **MC-HSDPA** (r10) (**up to 168 Mbit/s**)
- 4G:
 - **LTE** (r8): (FL) 300 Mbit/s, (RL) 75.4 Mbit/s
 - **LTE advanced** (r10): (FL) **1Gbit/s** [ITU: IMT-Advanced, true 4G]

From the bottom to the top



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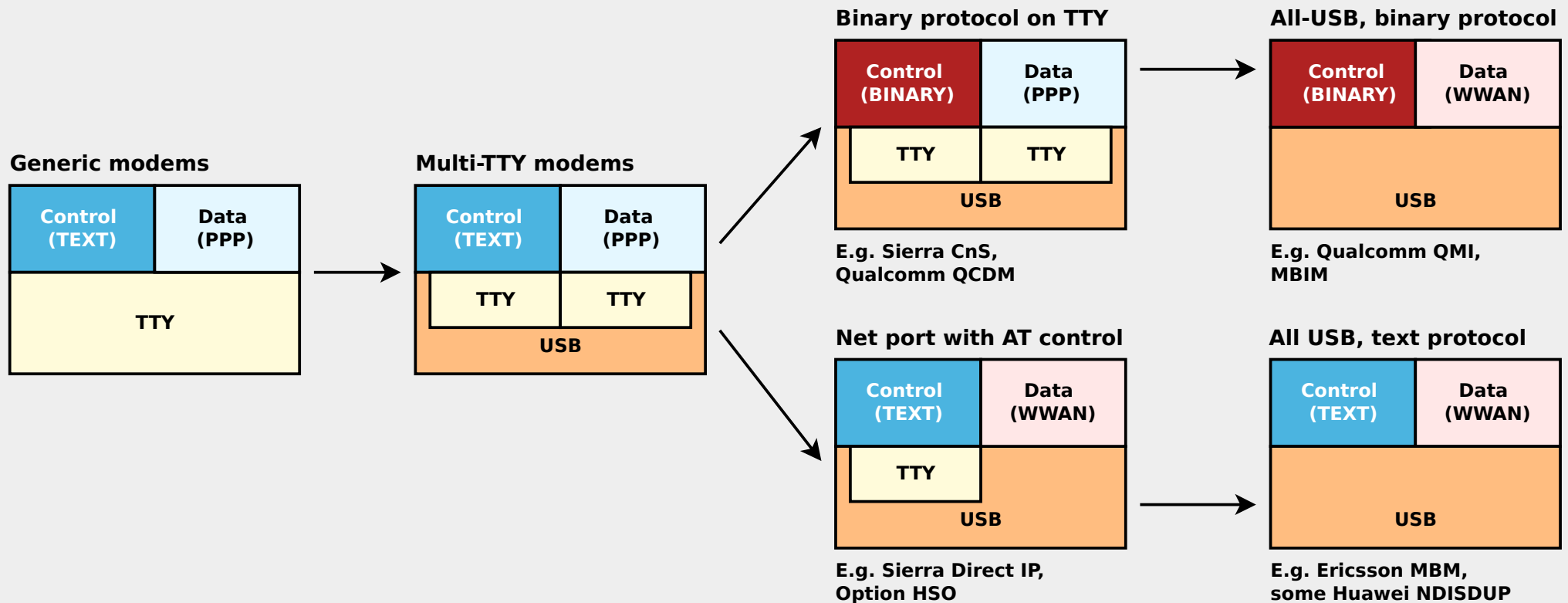
- **Userspace: user programs**
 - GNOME Shell
 - GNOME Control Center
- **Userspace: system daemons**
 - NetworkManager
 - pppd, dhclient...
 - ModemManager
 - libqmi, libmbim...
- **Kernel**
 - Control port drivers
 - Data port drivers



Kernel



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- **TTY drivers for Control ports**
 - Generic
 - Vendor specific (e.g. option, qcserial, zte_ev, sierra...)
- **NET drivers for Data ports**
 - Generic (e.g. cdc_ncm)
 - Vendor specific (e.g. hso, sierra_net)
- **Shared control/data port drivers: NET + cdc-wdm**
 - Generic (e.g. cdc_mbim)
 - Vendor specific (e.g. qmi_wwan)

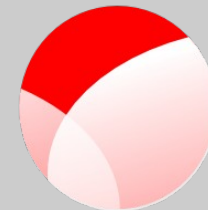
Kernel ↔ Userspace



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- **Control port**
 - TTY serial port
 - cdc-wdm port
- **Data port**
 - TTY serial port
 - WWAN net interface

GNU/Linux userspace: MM & NM



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- **ModemManager**

- Control port(s)

- SIM unlocking, Network registration, Signal quality, Location information, Connection setup (APN, auth*)
 - Primary & secondary ports
 - External libraries for some binary protocols (e.g. libmbim, libqmi)

- **NetworkManager**

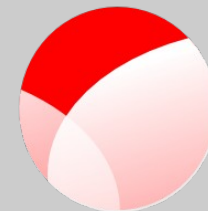
- TTY Data port

- PPP (launches pppd)

- NET Data port

- DHCP (launches dhclient or dhcpcd)
 - Static (netlink with kernel)

Thanks!



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+Aleksander Morgado

Freelance GNU/Linux developer

aleksander@aleksander.es

@aleksander0m

<https://aleksander.es>