

185 How to learn more about mobile (3G - LTE - 5G) core network engineering?

(self.networking)

submitted Fri May 8 12:28:36 2020 UTC by cygosw

Hey, I'm interested in studying how a cellular provider works, focusing on the areas of the core network and everything related to how a cellular client gets to the internet - what are the components of that process, which protocols are involved, and in general on what is the usual architecture / network design used for that purpose. I'm less interested in RF and everything related to what happens between the device itself to the RNC / MSC.

I'm of course interested in both 3G and LTE (and the differences).

Are there any recommended books, video tutorials or certs focusing in these areas?

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Colle1979 74 points 1 year ago

I am a core network engineer for 13 years. It is true that there is not much information on the internet. I usually use equipment vendor's documentation and 3GPP documents. I have gathered a few links quickly that look like might get you started, but you are free to PM me if and when you need further information or help:

- <https://yatebts.com/documentation/concepts/gsm-concepts/> - seems like a good place to start
- <https://yatebts.com/documentation/concepts/gsm-concepts/> - a tutorial
- <https://www.tutorialspoint.com/gsm/index.htm> - a tutorial
- http://www.eventhelix.com/RealtimeMantra/#Telecom_Networking - a great resource for call flows in telecom

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SuperQue 8 points 1 year ago

Interesting question. One thing I heard about telco mobile networks was that back in the early 2G/3G days, one of the biggest problems we (Internet networking types) ran into was that the telco networks treated mobile data like it was still serial lines.

The implication was that TCP over mobile worked like garbage, because the network would do a ton of packet retransmits, and delays, in order to keep the data stream serial. This would play havoc with TCP congestion and retransmit methods.

I haven't kept up with things since then. Does 4G/LTE/5G behave more like a packet network? Where packets lost over the air are allowed to drop?

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jiannone 17 points 1 year ago

Funny story. We converted from a circuit switched facilities based DMS/5ESS telco provider to an all IP telco provider starting around 2008. I grew up an IP guy. To put it lightly, the circuit switch grey beards were skeptical of packet switching and they enforced the weirdest architectural requirements on us because of it. Notably, they forced us to put their traffic into static ERO LSPs dedicated to specific sets of voice flows based on geography.

RSVP/IP people know that this is suboptimal. We did it because they demanded a "circuit" and were operationally clued enough to force us into suboptimal behavior. Basically, they wanted to be able to draw a line between a voice gateway and the PSTN, foregoing all the gains of resilient packet switching. If a wire broke somewhere in the middle, they wanted to go down.

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youngeng 8 points 1 year ago

4G/5G are packet networks in the core.

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UDP and SCTP are used.

You'll find a lot of tunnels (possibly GRE IIRC), DHCP and DNS (including relatively obscure RRs), VoIP, along with basic routing and VLAN in these backbones. This along with more mobile-specific concepts and protocols (like RRC), and things like ASN.1.

Disclaimer: I've never worked in that area, but I've studied it quite a bit.

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[–] [r0ut3p4ck3ts](#) 3 points 1 year ago

Depends on what you consider core. An "Evolved Packet Core" will explain the 4G architecture however, it does not consider a transport core, firewalls, and provisioning (to name a few and vaguely at that).

GTP, SCTP, GRE tunneling is used on the EPC elements and between elements of different function. RRC is a radio interface protocol, not a packet core protocol.

For not working in the area, not a bad dart your throwing @youngeng

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[–] [youngeng](#) 3 points 1 year ago

Yeah, I meant core meaning mobile network core (EPC), not "transport core" like an ISP backbone. Also, I was going off the top of my head.

Thanks, it's a fascinating area for a regular networking guy like me. I remember piecing together information about LTE to understand how the networking part works. I put together some notes [here](#) . Am I close?

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[–] [rankinrez](#) 8 points 1 year ago

It does.... but I would say the "bell-head" philosophy is still there to an extent.

Cellular networks have all kinds of things for "billing" and "accounting" of usage which is straight up descended from the "cost per minute phone call" model.

It's definitely moved in the right way, but I guess the legacy is perceptible. You can tell that cellular networks have not grown out of the IETF protocols but rather adapted them into what they do.

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[–] [r0ut3p4ck3ts](#) 2 points 1 year ago

3GPP is the standard body for wireless architecture.

Some / most of the elements are IP based so they *should* follow IETF standards.

I'm pretty sure most if not all wireless providers did away with "minute plans" back in 3G.

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[–] [rankinrez](#) 3 points 1 year ago* (last edited 1 year ago)

Go read the standards then. (In fact just even reading them you'll notice they're more like legislation than RFCs. The ITU in deep here.)

Tell me what the Gx interface is for or the PCRF or any number of elements.

Like I said there is a bang of bell-head all over the architecture. All that "per minute" shits been turned into "per bit" metering. Even if you've unlimited data the architecture is built to support metered services.

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[–] [\[deleted\]](#) 3 points 1 year ago

CDMA and WCDMA networks (3G) are basically good ol' cellular except there

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are some clever tricks at the last mile.

LTE (3.9G) put a lot of the complexity of the core network into the tower itself, but was basically only used for data. Speech, sms etc. fell back to older stuff.

Proper 4G networks are 100% IP. The whole cellular network starts at the phone and ends at the tower. It's just software and commodity hardware from there on.

Since now everything is IP based, you don't need fancy networking and fancy hardware anymore. So it made sense for smaller cells to put into stadiums, metro tunnels or even buildings.

Because of the whole 3.9G (but companies calling it 4G in marketing) and "true 4G" and other marketing fiasco, they decided to sweep it under the rug and call what basically was supposed to be 4.5G 5G and leave the complete disaster behind.

From a "core network" perspective, there isn't a core network anymore. It's all in the tower. 4G and 5G are closer to bluetooth or WLAN that are just externally managed than what cellular networks used to be. You can deploy a 4G network out of a suitcase and plug it into the internet.

Pretty much 100% of the headache involved is with simultaneously supporting legacy systems. If you don't need that (for example an oil rig or a festival in the middle of the desert) then it's pretty straightforward.

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[\[-\]](#) [Colle1979](#) [🔒](#) **1 point** 1 year ago

I'm not sure, but I don't think this was an issue when GPRS was introduced. Perhaps you are referring to a time when CSD (Circuit Switched Data) was used for accessing Internet.

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[\[-\]](#) [allexj](#) [🔒](#) **1 point** 1 year ago

Isn't GSM not used anymore since there is 3g 4g and 5g?

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[\[-\]](#) [Colle1979](#) [🔒](#) **5 points** 1 year ago

3G is considered GSM, and that's what OP asked for. CS Core is still used, and will be used for many years to come. For 4G and 5G you should look into EPC and IMS Core.

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[\[-\]](#) [0x2a](#) [🔒](#) [Shady Consultant](#) **29 points** 1 year ago* (last edited 1 year ago)

Everything I need to know about 5G I'm getting from Facebook /ducks

More seriously, this is a not so well-documented topic like plain old routing and switching. I agree with [/u/eternaldub](#) [🔒](#) that vendor documentation might be your best bet. Brands we've used are Huawei, Nokia and former Alcatel (now also Nokia), but there's of course a ton more.

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[\[-\]](#) [PotatoCabbage](#) [🔒](#) **12 points** 1 year ago

You can visit the official 3GPP website for more details, you can also visit this website: [moniem-tech.com](#)

He's a cellular guy constantly providing good info about cellular tech.

I've worked as an RF optimization engineer for almost 4 years and the whole cell infra can be divided into 3 main components:

RF Access layer, Transport Layer and the CORE Networks.

You can start with these concepts and dive deep from there.

It is pretty interesting and quite complex when you hit planes, protocol stacks and signalling.

Enjoy!

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[\[-\]](#) [vista_df](#) [🔒](#) **12 points** 1 year ago

The best introductory book that I've read on this topic was "From GSM to LTE Advanced-Pro and 5G" by Martin Sauter. It's a good read, focuses on both core and access networks, also the air interface, and presents the evolution of mobile networks quite well. I'd also suggest you watch his and Peter Schmidt's presentation 'Der Pfad von 4G zu 5G' (English voiceover/subtitles available) to complement the book on even more 5G content.

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[\[-\]](#) [feedmytv](#) [🔒](#) **3 points** 1 year ago* (last edited 1 year ago)

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Look into 3GPP. They have a lot of resources as they're the umbrella doing 5G NR. For LTE, my wife actually architected the non-RF parts of the network design for Alcatel-Lucent and survived the first Nokia wave. I can ask her, but as she sleeps in super late on Fridays I don't know when :)

I was so bored during corona I asked Peter to send me LTE/5G literature and a few days later I received a 300 page PDF. Cannot redistribute, but you know where to find him.

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[\[-\] on_the_nightshift](#) [CCNP](#) 9 points 1 year ago

At the place I worked, "core" networking was kind of separated from the mobile specific side. In that network (I was on the core side), it was all about redundancy/availability with duplicate hardware and circuits. We were all OSPF internally, BGP externally (duh).

There's not a ton of wireless carrier network specific books and training out there, but Cisco's Service Provider track is pretty good for most of it.

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[\[-\] eternaldub](#) 17 points 1 year ago

I haven't looked into it, but I hear of Nokia's program a bit in class and such.

Nokia 5G program

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[\[-\] flukz](#) 5 points 1 year ago

Look into 3GPP. They have a lot of resources as they're the umbrella doing 5G NR. For LTE, my wife actually architected the non-RF parts of the network design for Alcatel-Lucent and survived the first Nokia wave. I can ask her, but as she sleeps in super late on Fridays I don't know when :)

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[\[-\] smoakleyyy](#) 3 points 1 year ago* (last edited 1 year ago)

I learned a lot from this course: <https://www.edx.org/course/4g-network-essentials>

If you want to dig deeper into the mobile side, from here you can look into RF engineering courses/topics, or if you want to learn more about the core infrastructure side there's plenty of resources on networking.

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[\[-\] SpecialistLayer](#) 4 points 1 year ago

There aren't really many tutorials on this, mainly because those creating the systems are tying it together themselves. You say you're not interested in the RF side but then say you want to know everything related to how a client gets to the internet? Well, the RF involved is most of that picture because once the data is off the RF, it's on a fiber cable and follows traditional networking rules and protocols. Cellular networks are a combination of traditional packet based networking (When LTE is involved at least) and the RF. The goal is always to find the most efficient and fastest way to get RF based client's data onto the wire as quickly as possible so the RF spectrum it's using can be freed up.

If you want to learn this, I suggest trying to actually get a job with one of the carrier's, because outside of this, why learn this anyway?

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[\[-\] bajaja](#) 3 points 1 year ago

lot of good reading on your topic is on netmanias.com

also, are you just curious or do you want this as a career? surely you can apply for a junior voice engineer somewhere and do some numbing work and learn?

for employees of telcos there are many good documents on packet core. I don't collect them as my interest is in the mobile backhaul for 5G and there's lot of good documents available from vendors.

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[\[-\] r0ut3p4ck3ts](#) 3 points 1 year ago

I'm a core network engineer for a wireless provider working on our MPLS core. Prior to this position I worked on our access network.

LTE or 4G have a packet core which is the logical host (user equipment/cell phone) connectivity to serving and packet gateways for the user plane, and controllers for the control/signaling plane.

There are many ways you can design a transport architecture to have a 4G/5G encoder and "Evolved Packet Core" transported across a transport network. More likely than not you will find the core network similar to a service provider network. Also, you have backhaul from cell towers to some aggregation point. You could side bar down the path of the MEF (Metro Ethernet Forum) and also get an idea on how the access transport works as well.

I am happy to share some knowledge with you, but google search on 4g architecture will yield plenty of places to start that shouldn't get you in the rabbit hole of RF and all the acronyms such as SINR, MIMO, CQI, etc.

Good luck on your reading. I've been in the wireless industry for 10 years now and still learn everyday.

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[–] Theoreasis1994 3 points 1 year ago

For architecture 3GPP set the standards. Looking at their specifications/articles on the website might be helpful to you.

<https://www.3gpp.org/technologies/keywords-acronyms/100-the-evolved-packet-core>

One of the main things about LTE/5G is the very obvious separation of the user plane traffic and control plane traffic. Some network elements may have a hand in both (a PGW), or specialise in one (a PCRF).

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[–] pungentpasserine 2 points 1 year ago

I work on a 4G/5G core network for a living and I have to learn everything about these topics by either reading a 3GPP standard, reading proprietary documentation (less often), or having a colleague who did one of those things explain it to me.

You might be interested to know that the RNC is actually part of the access network, not the core network.

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[–] pradomuzik 2 points 1 year ago

My advice is to open your mind to have separate networks for control plane and data plane.

If you come from networking I'd say you can study the 3G/4G WiFi offload solutions. It may be a good "merging" point to enter this world.

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[–] ghoffart 2 points 1 year ago

There's <https://osmocom.org/> where hackers have created their own GSM/3G (and LTE as beta) stack, they operate it to supply thousands during special events. Including hardware and software. So, basically, they are their own mobile phone provider, and you can do that, too. This should give plenty of opportunities to dive in.

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[–] workinghardiswear CCNA 2 points 1 year ago

Just to assist in you search for materials, mobile networking and transport networking are fairly different ballgames with each having their own specific areas within themselves. My point is you will need to narrow it down as you arent likely to find something that covers everything from 4G/5G, TDM, DWDM, to IP/ethernet, etc.

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[–] caldog20 1 point 1 year ago

TDM and WDM are very important for transport for cell towers and core communication.

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[–] workinghardiswear CCNA 1 point 1 year ago

Well yeah something has to carry those bits but its going to be entirely different equipment, protocols, vendors, etc. Trying to take on the whole fuckin shebang at once just isnt feasible. People build entire careers on little niches within these fields.

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[–] caldog20 1 point 1 year ago

Oh for sure was just making a point that eventually those things will probably be something to get semi-familiar with as well.

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[–] stevedrz Studying Cisco Cert 2 points 1 year ago

Fantastic Ebook I found recently on LTE, I was really interested in QoS and how prioritization and throttling is handled.

https://www.academia.edu/38853685/LTE_Optimization_Engineering_Handbook

Also a good slide deck: https://www.academia.edu/11505739/LTE_Principle

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[–] tcpip4lyfe Former Network Engineer 3 points 1 year ago

Depending on what your goals are with this knowledge, the best way to learn would be to work for a cell carrier as an entry level tech.

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[–] xeroedouttwice 1 point 1 year ago

What are the general prerequisites for that kind of job?

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[–] tcpip4lyfe Former Network Engineer 4 points 1 year ago

At entry level you're a hut bitch, so basic IT trouble shooting skills. Maybe some help desk experience.

You're going to be driving all around gods green earth and waiting for engineers tell you to plug in a specific fiber connector for a while or swapping pre-configured dead equipment.

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[\[-\]](#) [r0ut3p4ck3ts](#) [🔒](#) **1 point** 1 year ago

This is not the best advice. These jobs are being automated and virtualize out of the network. A cell tower tech driving around will ultimately be more similar to a facilities maintenance technician.

If you want to troubleshoot layer 1 issues, this is the path to take.

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[\[-\]](#) [tcpip4lyfe](#) [🔒](#) [Former Network Engineer](#) **3 points** 1 year ago* (last edited 1 year ago)

This is the path a couple buddies I know followed. Started at hut bitch for Verizon and now they work on the network in an engineering capacity. You can't automate having someone plug in fibers at a new tower.

If you show interest in not being a hut bitch, are personable, and ask good questions, you won't be hut bitch for long.

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Which countries/companies engineered this stuff?

What brand of gear are they using? I've seen tower sites, lots of crazy equipment in there. Don't recall the brands though.

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[\[-\]](#) [r0ut3p4ck3ts](#) [🔒](#) **2 points** 1 year ago

Ericsson, Nokia, Alcatel Lucent. Nokia acquired ALU years ago, but these are the two biggest players in RAN and EPC equipment.

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[\[-\]](#) [cl3b](#) [🔒](#) **1 point** 1 year ago

Not sure how much coding background you have, but the Osmocom projects (OpenBSC and many many friends) will teach you a lot. All open source code of core network elements. If you can get a LTE eNodeB, you can run your own data network with something like NextEPC.

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[\[-\]](#) [stesasso](#) [🔒](#) **1 point** 1 year ago

You can start from here: <https://www.netmanias.com/en/post/techdocs/5904/lte-network-architecture/lte-network-architecture-basic>

And then look at other pages/articles in the same site. They have very good material.

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Instead of burning down 5G spots, take one apart, put it back, make a snap of its BIOS and disk and post it ?

Just half-joking with all those 5G burnout crowds, that were obviously "spontaneously" organised by Intelligence to thwart Huawei & Co ;0)

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I am trying to find information on the different 5G spectrum frequencies used. Some researchers claim certain bands ?60Ghz+? **alters the porosity of cell membranes**, allowing some molecules or ionic elements to move more easily across those members. **any alteration of the delicate structure of hemoglobin will impair its ability to bind with oxygen.**

I think this is why many doctors are saying that COVID-19 is a hypoxic injury depriving certain people of oxygen (similar to high altitude hikers).

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