0:17

okay guys

0:22

today um i'm going to talk about uh military computers

0:30

namely the computers in the defense sector

0:37

and the computation and the use of computers in military

0:45

as all of you are aware that there is a war going on an invasion of

0:51

russia going on in a neighboring country [Music]

0:57

so i decided to bring this topic

1:03

several weeks earlier and then it used to be

1:10

so if you have anything to say during the class or if you have anything to ask

1:16

please feel free to ask because as you said as i said before this is a competition culture class

1:25

there is no rigorous uh learning for a programming language or

1:32

algorithms or mathematics uh so discussion and question and answer

1:39

kind of interaction is considered a good thing

1:50

what i am

1:56

focusing on this lecture is what is the role of what is the role of

2:02

computers in the military and defense people say it is defense because it is a

2:10

it is more innocent word rather than attack

2:15

but usually

2:20

if there is a war one side is attacking other side is defending so defense and attack are

2:28

complementing each other in many cases if everybody is defending themselves

2:36

then who is attacking so but

2:41

the word defense is used widely

2:46

so these tasks that we are interested the defense industry is interested in computing are as follows

2:53

intelligence analysis of intelligence steve

2:59

embedded computing vehicle control and guidance avionics

3:05

meaning that aviation electronics organizing data for military leaders

3:11

and decision making decision support systems geographic data geospatial analysis

3:20

smart weapons communications encryption

3:25

with the communications simulation simulation of the equipment

3:31

explosions or simulation of the war

3:37

for example simulation of the russia's attack into ukraine so what happens when what

3:44

so since we are talking about artificial intelligence maybe artificial intelligence can

3:50

predict what's going to happen and through the stimulation

3:56

and uh surveillance radar data smart routers

4:03

and many other applications

4:08

and calculations of

4:16

calculations for uh military competition for military

4:22

has been uh in the area quite a while even before the computers were invented

4:33

the idea is you have a you have a cannon

4:39

forgive me if it's not a good cannon

4:44

so you are going to make a projectile

4:52

it's going to explode right so

5:00

what is your parameter this

5:08

alpha and what is your

5:15

output x also if you look from top

5:29

rotation is also a parameter but

5:34

that is basically something easier to compute it is directly related to the position so you

5:41

have to direct the correct position

5:48

in the in the basic form in the advanced forms there are other factors

5:59

so what you will do is

6:20

you have something like this formula

6:26

to

6:32

compute x and y coordinate depending on what alpha

6:37

and v 0 is so projectile is going out with v0

6:44

so there is basically a computation in order to hit somebody here

6:50

you need to compute compute and determine alpha

6:56

it is not just like aiming with a with a gun with the gun it is mastery because you aim

7:04

but with the cannon like this you have to compute

7:10

and if there is a wind

7:15

then you have to take that into account and theta will be theta prime

7:23

if there is wind in this direction also this

7:28

alpha will be alpha prime etc so there will be other factors if this guys is moving

7:39

assuming that this is a vehicle

7:45

so there is time

7:51

it passes from point a to point b at that time this will also move from position x

7:59

to position x prime so your computation should take

8:05

the new position x prime into account when the bump

8:11

comes to the new place you have to compute that

8:16

but what if this one changes location randomly

8:23

so competition is not even sufficient

8:29

you have to follow it so then

8:35

from [Music]

8:41

cannons

8:48

we will move to guided rockets

8:59

guided missiles guided missiles

9:04

change their head

9:10

as the target changes its position so how are you going to

9:16

follow there are different technologies some of them are heat seeking some of them are

9:21

radar based some of them are laser bait in some cases there is a plane

9:27

at the top that plane is putting marks

9:34

on the target and the missile is following the target marker

9:41

which is laser marker sometimes or

9:46

information connection information connection

9:53

is established between missile

9:58

and the avionics plane plane at the top

10:07

some missiles have self-contained radars

10:12

that can follow the target so the problem gets

10:18

complicated as you move through the ages

10:25

sometimes this target is intelligent so that it can fake

10:34

the detector of the missiles so that missile will incorrectly calculate

10:42

the position and will fail so it is jamming the

10:49

radar so there are a lot of technologies and counter technologies

10:56

that are used to

11:04

compute things that are necessary in the

11:13

defense usually some form of

11:23

some form of heating

11:29

is the norm

11:34

in addition to that escaping

11:40

jamming hiding

11:48

technologies

11:54

are also used in addition to the basic goal of hitting

11:59

or avoidance like escaping

12:09

so uh let me

12:15

let me give you a video so that you get some form of

12:23

motivation a short very short video about

12:29

a command control central of nato

12:34

i think it was in europe let me see

13:05

let me know if you don't hear the sound

13:30

[Music] we had in the old scenario always a calculation the longest time you fly

13:38

with a fighter bomber over germany is if you go from the czech border to

13:44

the bodensee and that takes you less than 15 minutes this is enormously fast

13:50

this this also shows how reactive air defense forces must be and how integrated they must be in order

13:56

to counter especially surprise attacks and that's that's why why this integration aspect of air defense is so

14:03

important

14:18

axialize nato and the nations to manage air operations both over nato european territory and out of area when deployed

14:27

it combines the planning tasking and execution of all air operations by integrating functions such as aircraft

14:33

control air traffic control command and control and airspace surveillance amongst others

14:40

axe is replacing nato and national systems and will interconnect more than 20 military aircraft control centres

14:46

including the headquarters allied air command otherwise known as aircom in ramstein germany

14:52

aircom delivers air and space power for the alliance its mission is to protect the nato european airspace on behalf of

14:58

the supreme allied commander europe this responsibility is delegated to two combined air operations centres chaoks

15:06

in torrejon spain and udum germany as well as one deployable air command and control center in pogo arenatico italy

15:14

axe will interconnect these three chaos in the future increasing the effectiveness of nato air operations

15:21

[Music] the italian aircraft control centre in poggiornatico was the first accident to

15:26

achieve operational status in may 2015.

15:38

in italy as a country the beauty of accs is using the system for

15:45

the non-real-time portion so the planning phase of a campaign for instance and the real time for instance

15:52

managing an alpha scramble for for a real for a real case

15:57

[Music] we are one of the satellite stations of aircom and we're providing with the only

16:04

deployable unit for nato that provides recognized air picture for nato anywhere in the world

16:12

basically we have a deployable aoc which can also anywhere in the world provide a

16:17

planning of an air campaign on a small scale because we're a small unit [Music]

16:30

x is basically the operating system that we're working is so it's an enabler for our missions what is the most important

16:36

thing is that we provide a picture to link between the tactical and the operational level so what we do here the

16:43

picture that we provide with x can be linked directly to the higher headquarters so they know what's going

16:49

on and they can take their decisions based on what x and our system is providing to the higher headquarters

16:58

in january 2016 the nato kaok for northern europe achieved early operational capability for acts

17:06

when the system went online here and we first started running the system operationally and trying to do air

17:11

policing with it we there are a lot of people wondering if the system would just falter and fail and we would just

17:17

say okay we'll just revert back to legacy system that didn't happen so it's been pretty stable and that's been a

17:22

surprise for us but it's been a good surprise and and we've been touting that as a success

17:27

[Music]

17:34

the next sites to get acts will be glance in belgium and lyon in france in 2017.

17:40

when fully deployed axe will cover 10 million square kilometers of airspace

17:47

the most important thing i think is integration with older systems because if we are the only ones that have acts

17:52

and the rest of the world doesn't have it and we cannot integrate with them then we're useless [Music]

18:00

by three x entities if you imagine small missions in italy and it was

18:07

confident uh there's going to be a big success of nato pushing on this program

18:12

i am an operator i am a user but i do that's good enough

18:18

so as you see this is the latest technology they were working on

18:30

let me make this smaller

18:47

okay so

18:53

now you have some kind of understanding uh what people are up to

19:01

you pro some of you probably know much more than

19:08

general knowledge on this some students are very into

19:14

military things [Music]

19:23

another one

19:28

was a russian millennium computer system

19:34

that's that's a about 20 years old now

19:42

should we watch i will i will show it later but

19:56

one thing is maybe i should

20:11

yes

20:39

[Music]

20:49

that's radar

21:04

[Music] foreign

21:10

[Music]

21:23

so this kind of devices they have that's the [Music]

21:29

those are the main boards processors

21:37

replacement

21:46

the time etc these are hard drives

22:10

so an interesting coincidence uh on these

22:16

is that actually uh my father

22:21

worked in nato in 1962 uh in italy

22:27

the image you see is the today's picture of the abandoned underground

22:34

bunker that my dad was worked three days a week for two years

22:42

i showed the images and he remembered and

22:48

see there is a map of turkey there and this is the command and control center that my dad was working

22:55

today and this is one of the computers later

23:00

brought there and these are the bases

23:06

where airplanes were located

23:12

at that time so similar operations that you have seen at the beginning video

23:18

about uh 60 years ago

23:25

starting from 1955 1955 yeah

23:31

that was that's af salt base

23:37

in 1955 yes

23:43

so when did it happen in addition to calculation of the hitting position

23:50

there was also a scrambling and communication

23:55

uh requirement the first one uh first famous one is the

24:02

enyak [Music]

24:08

although it was oops

24:18

although it was primarily used for calculating artillery firing tables

24:24

again i said uh since it was taking too much time they were generating tables for the

24:33

look up tables

24:39

they generate tables for the artillery for the cannon and when needed

24:44

a person was looking at the table uh printed to adjust

24:50

the weapon but later

24:57

it was also used for other purposes such as

25:03

development of the nuclear bomb as well

25:13

one part of the there are multiple dimensions as i described at the beginning one part is

25:19

the communication another part is intelligence uh

25:25

computing firing tables but vehicles mostly

25:32

planes are today very important tools planes and drones

25:40

starting from 1960s

25:45

advanced planes were [Music]

25:52

manufactured as technology improves and capabilities

26:00

improve the amount of software and amount of

26:06

computing computing power in airplanes fighter airplanes

26:14

increased significantly this is phantom plane

26:20

where they thought that after this time

26:29

people will not be doing dog fighting rather

26:35

they will send missiles from radar distance so that is how they

26:41

switch to f4 phantom [Music]

26:50

and they have assembly language

26:57

control and operations in the onboard computer

27:03

and it was very small later in 1970

27:11

keep in mind that these are not new planes

27:18

45 of the requirements

27:28

was software requirements in the f4

27:33

only eight percent of the requirements were software requirements but in

27:38

10 years half of the requirements became software requirements and software capability

27:44

in an airplane in 1980

27:50

there was another uh airplane that we didn't have

27:55

eighty percent of the requirements were for very requests

28:02

in total it is programmed in ada language

28:09

when we hit f35

28:23

25 million lines of code is present

28:30

it's mostly cnc plus plus rather than ada

28:36

because uh in these years uh nobody is

28:41

learning ada as a programming language so companies that manufacture planes

28:47

couldn't find people who know ada very well therefore they switch

28:54

to cnc plus plus instead although ada had more advantages

29:02

i am going to talk about that later so

29:08

when we focus on f35 number of lines

29:14

of software is 25 million in a in an airplane in a boeing modern

29:20

airplane passenger airplane i as i remember it is like 6 million

29:28

lines of code seven percent of that is assembly language five percent is ada

29:35

25 percent c plus plus 50 percent is c programming language so you understand

29:41

why we are teaching you c programming language and then other uh

29:46

languages rather than python in the first year

29:58

[Music]

30:10

they have they have different systems connected for example they have a radar system

30:17

they have a computer system each of them is supplied by different companies for example f-35

30:24

in the f-35 project even turkey was also in the group so different companies are

30:31

providing a different components and each company is selecting provided that

30:36

the requirement is met selecting different types of software i believe

30:43

parts coming from ada was older and fixed

30:48

very well working devices like altimeters or

30:57

some mechanical control things that has been

31:03

used before so they didn't change it after testing and modifying it

31:09

they used it as before but the new ones are usually

31:16

that's what they say so they switched from ada to

31:21

c due to programmer availability in the market in the job market

31:28

but as i as i said i repeat they are not even considering using java

31:33

or python or other high-level languages

31:38

[Music]

31:44

that's one uh motivation picture

31:52

originally uh before the s 400 crisis we were about to get 100

31:59

100 f-15 planes along with along with australia

32:05

italy canada norway japan etc

32:12

f-16 when we come back to f16 uh that is dated back to 19 1970

32:19

uh 500 lines of code were present in 1984 so they continuously increase

32:26

and modify the plane uh by the 1990 one million lines of code were present

32:34

primarily programming language was ada uh it is used it is a programming

32:40

language that helped to beat the mainstream air force navy in the united states

32:47

for the planes for f-15 f-16 f-18 whatever and also in other

32:53

military systems for ground operations

33:02

at the beginning f-16 had analog system for flight control computer but later

33:10

after 1980s later deliveries

33:16

were electronic uh computer-based digital computer based

33:23

flight control computer at the beginning it was analog

33:30

like an electronic circuit

33:37

um when thinking about ada

33:44

there are still companies who are pushing ada for military operations uh

33:51

one of them is ada core the idea is

33:58

normal in normal languages bug fixing and backfinding is

34:04

mostly delivered to expected from the developer developer is

34:10

expected to do a lot in terms of reliability in terms of

34:16

fail-safe operation but the language ada

34:21

is designed by keeping these failures

34:27

in mind so you cannot make mistakes because most of them are typed

34:34

most exceptions not most all exceptions must be handled

34:39

therefore it is kind of a reliable language from

34:45

the design i have taken ada programming course in master's level

34:52

it was an interesting language it looked like pascal

34:57

but type checking was very good

35:03

so it was very hard to fail whatever you do from the input

35:10

your program continues to work

35:16

doesn't crash

35:22

so the name of the programming language is

35:30

given today also

35:36

it is the day of world woman's day so ada is an interesting name for today

35:42

actually uh syntax is good so human readable form

35:47

it's like pascal programming language control statements are structured uh there is strong type checking data

35:53

composition is nice code modularization is subprograms procedures functions are

36:00

available object oriented

36:05

library and component support is there exception mechanism is very good

36:12

detecting responding exceptional run time conditions such as division by zero

36:18

okay division by zero it never makes a problem with the ada programming

36:24

language and since there are typed and constrained

36:30

operation the failing of the program is less likely that's why

36:38

it is designed for military and it is used by military and military contractor companies

36:45

[Music] f-22 raptor had

36:51

1.5 to 2 million lines of code from the beginning and it also used ada programming language

36:57

ada 83 which is a

37:04

modified version of ada a modern version of eta and it was very successful

37:12

let's come back to s400 i searched

37:18

this yesterday after because there is a ukraine thing going on i searched for s400 as well

37:26

so it's an interesting missile there is also s500 available

37:34

one thing i realized that

37:41

the speed of the s400

37:52

so 17 000 kilometers per hour that is the speed of s 400 rocket

37:59

it is basically mark 14

38:05

so 14 times faster than the speed of sound and basically

38:12

5 kilometer per second so you have to be very fast

38:19

in order to hit the incoming airplane or incoming missile

38:25

on your airspace it has a radar and it is also tracker

38:38

it is guided so it can change direction on air

38:45

and what is special about it uh they have special made

38:52

uh russian comp russian computer in s 400

38:58

named elbrus 90. elbows project was an

39:04

as in the soviet times it's an

39:10

complementary to intel and ibm and motorola

39:17

and soviet republic tried to develop their own

39:22

microprocessor and computer below you see elbrus microprocessors

39:32

from the top and over the years it is still continuing in

39:39

russia for example at 2 gigahertz in 2019 airbus 16s

39:47

which is what not here but s8 sv is here

39:54

2 gigahertz 1.5 teraflops so it's quite a good processor

40:03

um

40:10

one of the professors in our department it's an interesting fact

40:15

uh was russia before you guys came in she it

40:23

it was she and the professor

40:31

they are retired now

40:41

she said she worked in elbrus project

40:47

when she was in russia in the before 1990s

40:59

her husband was also in environment department

41:07

in gibson so what kind of computer they have this

41:15

is from inside s 400

41:21

cabin and that is the micro computer that's what

41:28

you see on the right so this one

41:35

they have taken a shot from this area from outside

41:40

i am talking about

41:46

this

41:53

there is one this is radar on the right

42:02

this is rocket launcher

42:11

this is another rudder and this is altitude radar so multiple

42:18

radars track and the target and combine information

42:24

as the rocket is moving through [Music]

42:29

the target so they try to hit

42:35

targets with multiple types of rockets some some type of rockets are for missiles other types of rockets are

42:42

for the planes for different distances depending on how you position your

42:49

how you position your s400 or s500 the idea actually is

42:55

from point a to point b hit

43:02

and this your speed is five kilometer per second so it's quite fast

43:08

this is also fast this is like one kilometer per second

43:14

a plane so that's how you hit a plane

43:19

but you still have to track

43:25

the plane so that tracking information must be so supplied

43:30

to

43:36

the rocket if i'm correct however uh i searched little while

43:46

and realized that for when you are using stealth

43:51

technology the radars of the s400 doesn't work

43:59

so when you are using f35s in stealth mode

44:06

in the jamming mode what they say is these radars are ineffective

44:12

so they cannot track if they track you can hit but if they don't track they cannot hit they also says

44:20

they also said uh

44:27

the s 400 is also kind of ineffective against drones

44:34

i've read it somewhere

44:40

okay enough for s400 but

44:46

there's a quite bit of computation there because you need to compute that result

44:51

very fast manner and

44:58

it has to be correct otherwise you are going to get killed secondary thing i'm going to come back

45:05

to this but these are also ground units

45:14

since they are ground units they're also vulnerable

45:20

a plane can hit back so for that purpose

45:27

these are relocatable

45:32

movable things that's why we see them on trucks

45:40

they are trucks because they change their position every day they can change their position

45:45

every day otherwise they can get hit by artillery or by planes

45:51

they also have should have countermeasures so that

45:57

they hide themselves

46:11

in order to hide

46:16

there is a guy here another guy here

46:21

this guy has a radar okay

46:29

this guy has

46:34

walkie-talkie

46:40

they are communicating okay

46:46

in order to not get killed by this guy

46:53

because this guy has a missile

46:58

and these are communicating if these are communicating from the single frequency

47:08

the position can be found in a relatively

47:14

shorter amount of time because in the spectrum

47:20

in the wave spectrum you have a certain

47:26

energy distribution that energy distribution is detectable

47:32

by a tuner if you are searching for a frequency up you can find the communication frequency

47:39

and you can listen and you can maybe locate the position what they do is and there is also a

47:46

noise what they do is

47:52

frequency hopping

48:01

okay which was also invented by a woman

48:06

also an act on also an actress

48:12

i'll remember the name now if you can remember

48:19

you can say also very frequently

48:26

you change frequency

48:31

among those so net energy density in the spectrum

48:40

will not be detectable so they cannot detect your frequency very easily because it is randomly

48:46

changing based on the protocol arranged by the receiver

48:52

so if these are changing frequency in a very fast fashion

48:58

it cannot be detected and it cannot be located therefore frequency hopping

49:03

communication is one of the essential techniques of communication

49:09

in military otherwise you you you can get detected and you are also you also get listened to unless it's an

49:16

encryption if there is an encryption they can also try to decrypt etc

49:21

but mostly it is for location detection

49:28

with multiple antennas

49:37

you can detect location and hit the communicating person um

49:44

[Music] one guy was killed in

49:50

azerbaijan who was very into

49:56

turkish people by

50:02

detecting the cellular phone location in a meter

50:07

resolution like this and

50:13

el chibe i think abu fazel was killed

50:18

uh using this technique because he was using non-military grade

50:23

non-frequency hopping regular cellular phone and the phone numbers phone number was

50:30

[Music] maybe it was transceiver i don't know

50:35

but it wasn't frequency protected for the location

50:42

he got killed with a rocket

50:55

let me remember

51:26

now i can do it hey the lamar i'm going to show it to you

51:33

where is it

51:38

uh the frequency hoping technique was invented by edelmar

51:44

who was also a hollywood actress uh that is

51:50

this is this is her patent actually

51:56

spread spectrum technique

52:05

let's go back and

52:11

see how apollo computer was like

52:17

there is a film related to apollo computer how they make the apollo computer

52:30

there is also another woman

52:38

who was very famous

52:43

this guy a show

52:49

it's hamilton this guy hamilton

52:55

working in apollo computer uh that she was making there

53:07

she's still alive

53:17

this is this is her

53:24

anyway that computer was this computer that she programmed

53:30

mainly

53:36

in this picture we'll see bill gates bill gates is behind

53:47

to two megahertz

53:57

15-bit structure 2k ram magnetic core memory small cores

54:04

magnetic cores and 36

54:09

000 words they won't say bytes because it is 15 bit

54:16

rom so it has hand controller input run the

54:21

radar blending radar receiver engine command reaction control system input and output

54:27

ports 50 watts of power and 32 kilograms that was this is the

54:34

computer and if you are interested there is a nice video that made by mit

54:41

describing how this corporate how this computer is operating and what detect what kind of technology is used

54:49

in that and it is made in 1966 that is one of the mania miniaturization

54:57

processes in military and space programs

55:06

so let's review what we have in the communications the computers

55:11

provide direct network to allow multiple lanes of communication between various parties within the

55:17

military as i said frequency hopping encryption

55:22

are very important and cannot be done without com without the help of the

55:27

computers second administration in the military

55:34

so there is a huge amount of administrative things going on like

55:40

ask election visiting and day-to-day operations

55:46

i mean salaries expenses

55:51

buildings all kinds of operational things that are related to military as

55:58

are also done through computers

56:04

in terms of defense and military tasks one thing is as i briefly described at the beginning

56:11

is the guidance and tracking yeah

56:20

some of them use laser guidance some of them are using heat sensing heat

56:26

seeking control some of them use gps and some of them

56:31

are using gyro system so independently positioning itself

56:37

with respect to previous position

56:42

um they have loaded the map into their computer

56:49

because of the jamming possibilities and because of the gps

56:54

shutdown possibility some advanced missiles use

57:00

camera so they check what's around and they try to position

57:07

themselves based on radar camera etc

57:12

to understand where they are and where they want to go if the target is moving

57:19

it could be marked with a laser using a by other tracking device so that the

57:26

missile is following the laser point laser point is marked by

57:33

other person like a pilot or other

57:39

tracking device with a radar in that case laser guidance does not

57:45

require radar heat sensing is easy

57:50

because if you are trying to hit a plane or a tank usually they are

57:59

they have engines and that that are hot so if you can have a mechanism that follows the heat

58:06

adjusting the position to follow up the heat then you can hit the target unless

58:14

there is a counter measure

58:21

the term avionics is interesting er aviation electronic so everything that

58:27

is related to everything that is related to airplanes

58:33

in terms of electronics and control is named as avionics

58:39

including computer this is i think

58:46

f 104

58:54

maybe yeah for this

59:00

you see a lot of equipment is there

59:06

all of them are reviewing executed for the play

59:15

using computers uh to improve the skills of the soldiers

59:20

are also as a task

59:27

computer interfaces battle interfaces

59:34

are necessary to empower the soldiers

59:40

whether they are fighting in front or fighting at the back for example a tank

59:45

operator tank operator has a user interface and there's a situational awareness issue if

59:51

somebody is shooting from behind the computer should notify the tank operator

59:58

saying that there is shooting coming from behind so turn back so computer assisted

1:00:05

operations and human company interaction is interesting for the battlefield operations

1:00:15

because computers are going to be operated by soldiers

1:00:20

so computers must be operable and soldiers must also be educated

1:00:26

for the comp computing facilities

1:00:35

then when we talk about education now comes the simulation part

1:00:42

so during the peace time we should educate soldiers pilots and everybody

1:00:50

through simulators not only the pilots and the drivers but also soldiers can be educated through simulations through war

1:00:56

simulations etc for the upper management there is the

1:01:03

decision support system this is from who this is from the old time and the one on the right is the new

1:01:12

new time decision making is very important in military operations

1:01:19

therefore data presentation data visualization simulation and prediction

1:01:25

those are very important factors of the decision support and in

1:01:30

coming years more and more artificial intelligence will play role

1:01:36

in the decision support systems because most decisions will be

1:01:43

taken by algorithms rather than [Music] people

1:01:52

there are new technologies uh in the battlefield uh i'm going to talk

1:01:57

briefly on that uh one of them are drone technologies

1:02:04

and variable computing variable devices and autonomous devices

1:02:11

[Music] drones become smaller

1:02:16

for example each soldier may have a personal drone

1:02:22

that kind of thing can happen variable sensors

1:02:27

in addition to night vision you may have additional sensors that increases the perception

1:02:34

information processing capability during the battle

1:02:41

smart guns integrating laser finder and automatic

1:02:47

automated shooting technologies that help

1:02:52

that help the soldier so you don't have to aim that much

1:02:59

the gun automatically finds and detects and aims itself rather than

1:03:06

relying heavily on human operation and secure

1:03:12

whenever you see a military computer military device it looks like it is

1:03:19

painted in camouflage or green and it looked like this

1:03:26

aside from that requirements are different

1:03:31

hardware requirements are different temperature requirements are different each chip

1:03:39

for example commercial chips are designed to operate under zero and

1:03:46

70 degrees industrial chips

1:03:51

are in two kinds one is minus 40 plus 85

1:03:57

minus 40 105. so these are industrial and automotive grade computing chips and

1:04:03

for example when you are buying a flip-flop or small chip that is

1:04:09

let's say arduino it doesn't work in military environments because in high

1:04:15

temperatures it doesn't work well it makes errors so therefore military chips have

1:04:20

different standards and each chip has different labeling

1:04:27

on it to indicate it's a military ground military grade chip so manufacturing is more expensive

1:04:35

cars are more expensive there is a shock resistance requirement and there is also a temperature resistance requirement

1:04:44

sockets are different military sockets are different usually they are round

1:04:52

and with the threads

1:04:57

uh that makes it expensive only so internally they are the same

1:05:04

also the paint is different to make it look like more expensive

1:05:11

drone operations from the air and from the land

1:05:17

is very interesting united nations uh

1:05:23

has an agreement on banning unmanned land operations

1:05:29

but autonomous autonomous land operations but it is not clear yet so it

1:05:35

is under the development phase whoever develops it at the beginning will have

1:05:41

more advanced front in the race

1:05:47

so these are for example autonomous tanks autonomous machine guns

1:05:53

so they can they can be operated from remotely or they can operate autonomously

1:06:00

by themselves in the military power is very important

1:06:06

factor so when you are designing something for the military

1:06:12

how much power your device is taking is an issue because it has to

1:06:18

withstand extended amount of waiting extended amount of

1:06:24

carrying by the person so powering laptops powering devices

1:06:30

powering communication devices is crucial so that kind of technology

1:06:37

is also developing both reducing the demand also

1:06:44

generating the power

1:06:52

anything else you want to ask

1:07:01

who is going to win the war

1:07:10

let me turn off to recording