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CCP Games
Single Sharded Persistent Universe
Everyone is on the same server
Over 8000 solar systems to visit



This is EVE trailer

MMOG

Single Sharded Persistent Universe

Everyone is on the same server

Over 8000 solar systems to visit

<https://www.youtube.com/watch?v=AdfFnTt2UT0>



Blood Raider Shipyard

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GAME_AI_NORTH 17

- Provide Player vs Environment Fleet Fight Experience
- Deliver High End Loot
- Large Scale Group Content
- Feels Like Fighting Players



- Last summer we released a feature called Blood Raider Shipyards.
- It introduced large scale fleet fights between players and NPCs
- Hundreds of NPC ships fighting and trying to emulate player behavior while defending a massive Shipyard.



Blood Raider Shipyard: Overview

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Let's do a quick overview of how this feature works.



Blood Raider Shipyard: Overview

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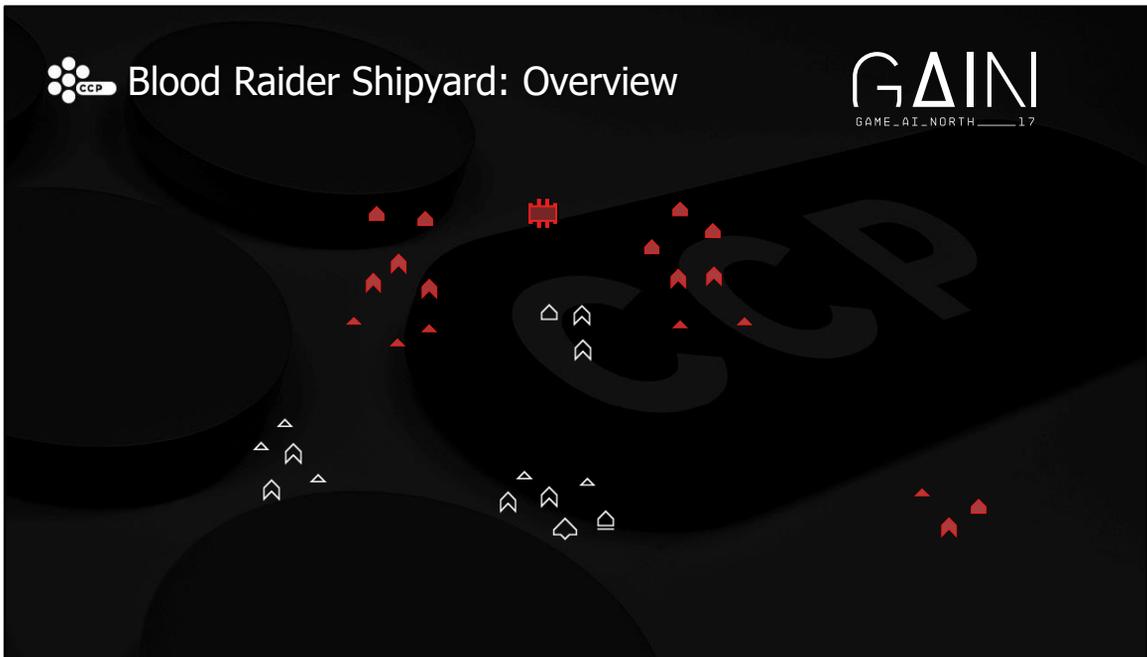


We start with a massive pirate shipyard that players have to search for and locate.



Blood Raider Shipyard: Overview

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When the players get close the pirates will respond by deploying a defensive fleet
If the players stick around or bring friends we will keep spawning reinforcements until the players give up or take down the shipyard shields



Reinforced
for
24 Hours

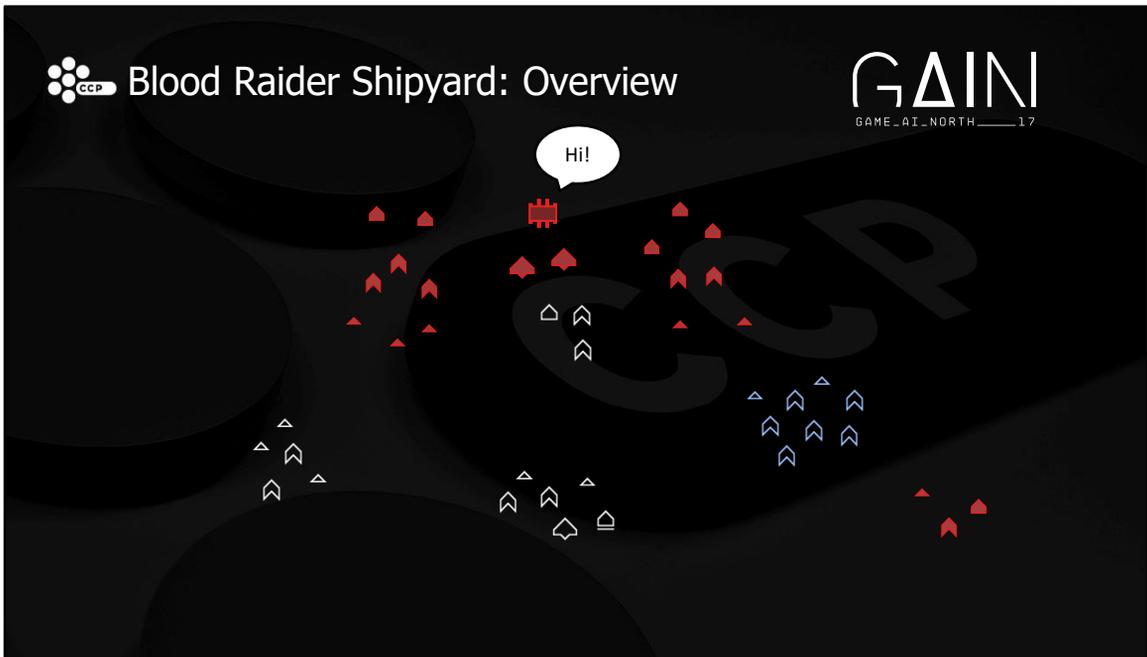
When the players manage to get through the shields, the shipyard it enters reinforced mode.

It becomes invulnerable for 24 hours and stops spawning reinforcements.



Blood Raider Shipyard: Overview

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When the shipyard exits reinforced mode it becomes visible to everyone in the solar system.

And the cycle starts again. Players arrive. Pirates Respond. More players and more pirates.

But now there is a significantly higher chance of a rival group of player wanting in on the fun.

Which will escalate the defenses as well.



Before we go in more detail about the Shipyards I want to talk a bit about the feature we did prior.

In 2016 we released a feature dubbed Mining Operations.

There we introduced small scale fleet fight in the form of NPC miners and their defense fleets.

These are NPCs mining fleets that show up at asteroid belts and compete with players for the resources.

We are still getting bug reports that they min out entire asteroid belts.



Mining Operations: Miners and Haulers

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We created NPC mining gangs complete with haulers to collect the ore. They compete with the players for valuable ore in the asteroid belts. If you destroy miners or hauler they can drop the collected ore as loot along with some extra swag if you get the haulers.



Reusable NPC Ship Types

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In an attempt to mirror player behavior better and make it simpler for players to understand our feature

We introduced reusable NPC types that can be shared between different factions. As part of that we introduced dynamic skinning on NPCs using the same tech as player ship skins.



Mining Operation: Defenders

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And when attacked we call in reactionary forces to defend them.
We had forces from 12 different NPC corporations from the 4 main races
And 5 different pirate factions in addition.



Emulating Player Fleets

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- We introduced player like stats based on real ship loadouts
- We wanted NPC ships to better match player expectation based on how players would use these ships
- We still haven't not able to assemble these ships dynamically
- We still have to create new types for each fitting we need.



Distinct NPC Combat Roles

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For the defense forces protecting the miners we created different roles similar to what you find in player fleets.

Commander, DPS (damage dealers), Logistics, Electronic Warfare, DPS

Anti-Logistics

Anti-DPS

Commander chosen from the DPS

Iceland Just Qualified for the World Cup 2018



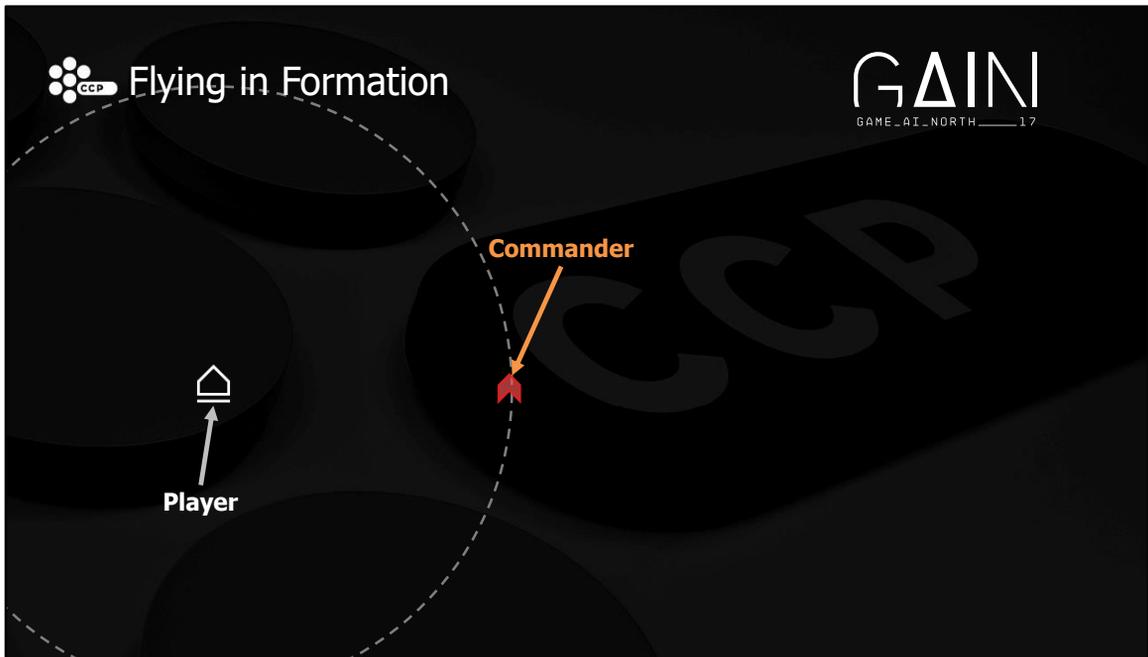
Flying in Formation

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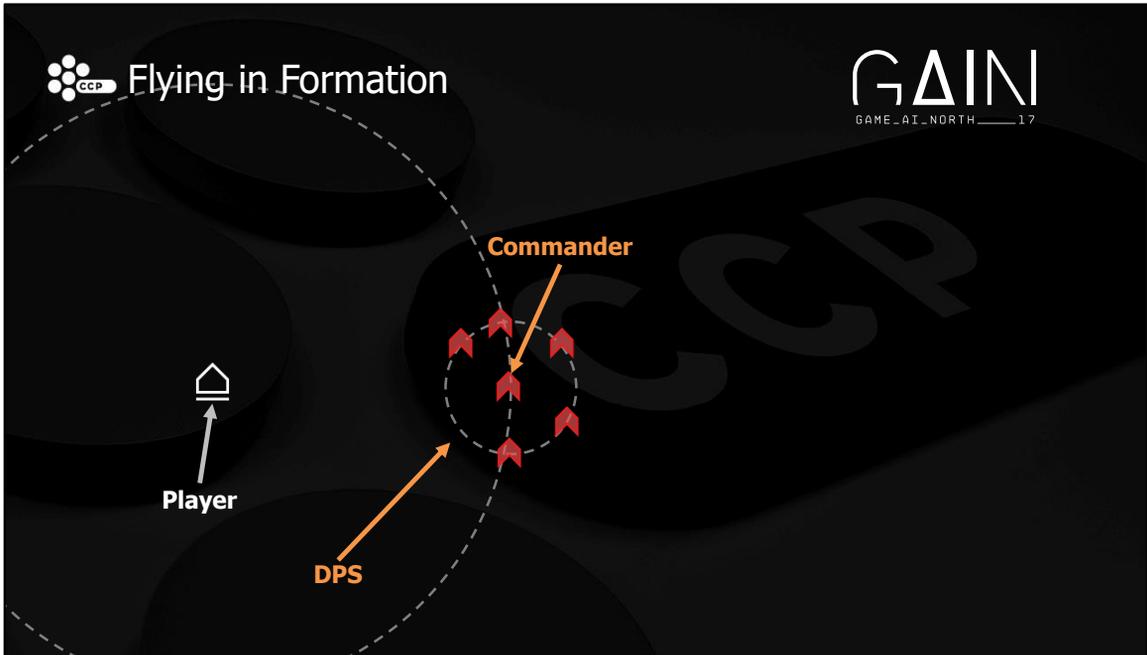


Player

To properly take advantage of the our combat roles we needed to fly the NPC in formation similar to how organized players tend to do.
Given a combat target.



The commander chosen from the DSP ships will orbit the target at an effective range base on his weapons.

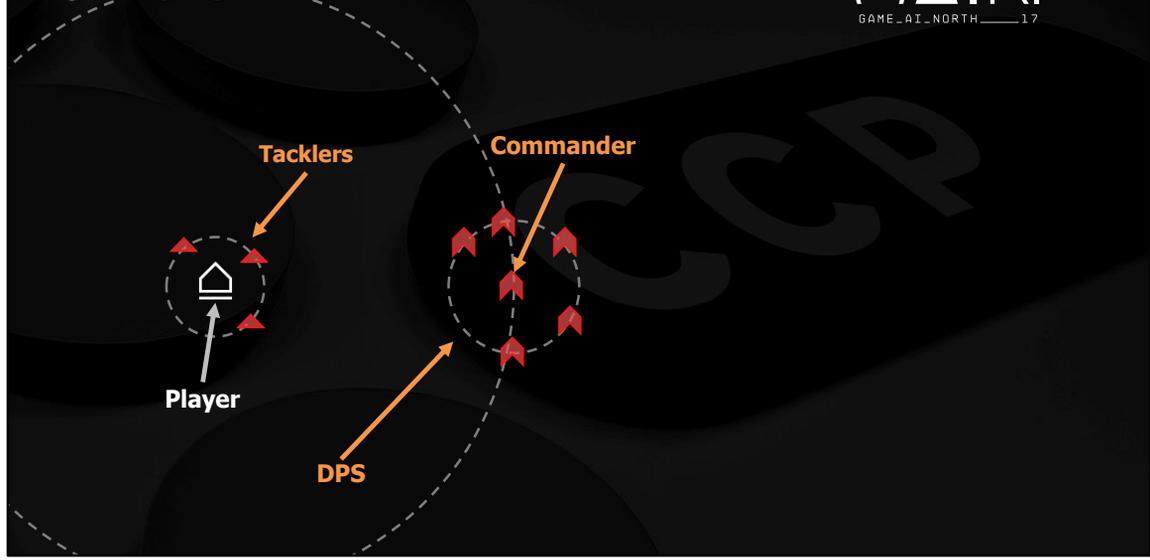


The other DPS ships will anchor on the Commander by orbiting around him.



Flying in Formation

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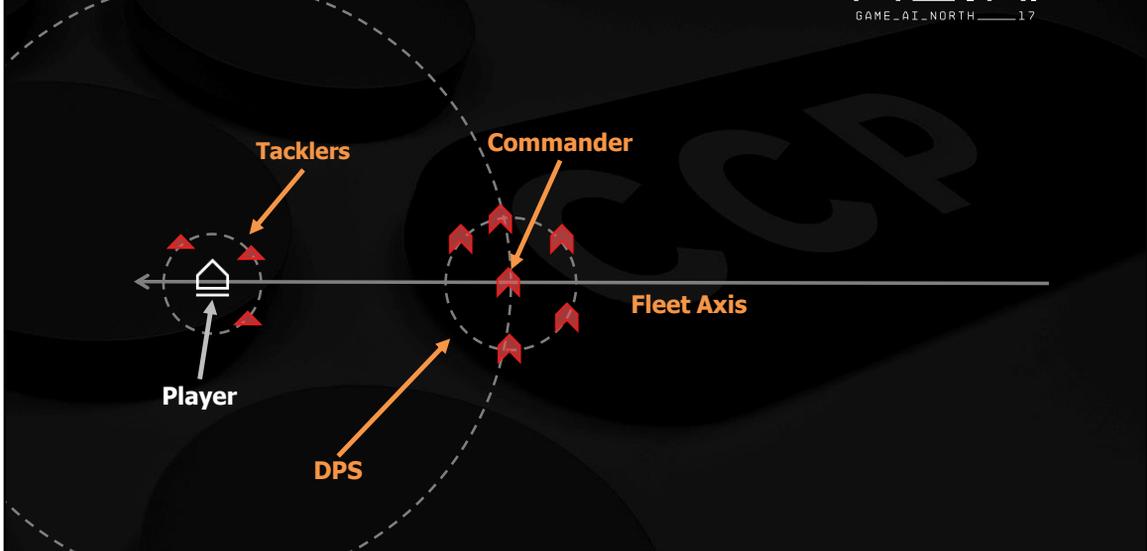
Wizard Staff Formation!

How about a video if this in action



Flying in Formation

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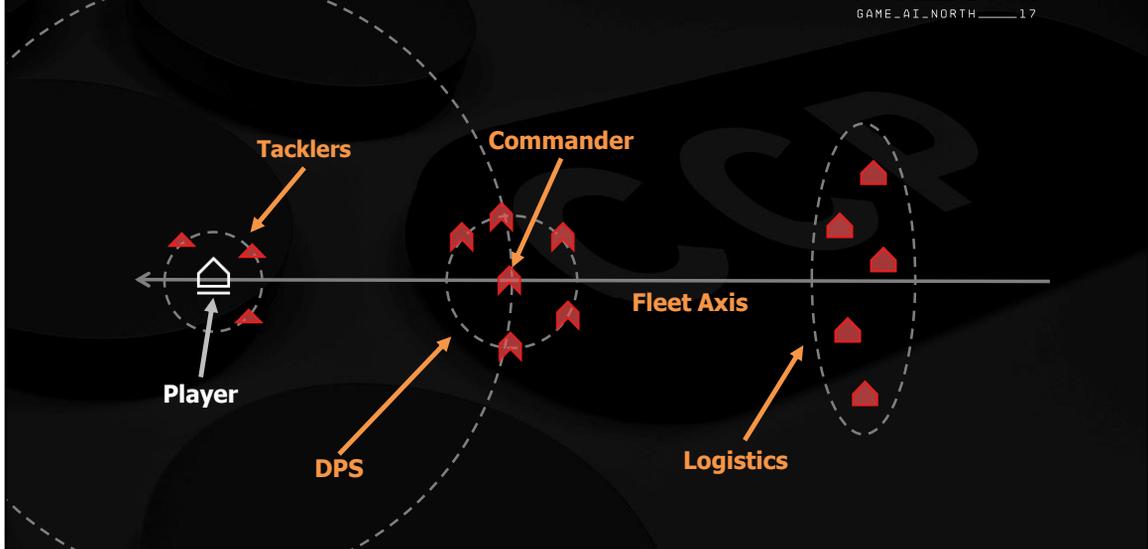
By drawing a line from the commander through the target we can define a fleet axis.

Enemy Gate is down (Enders Game)

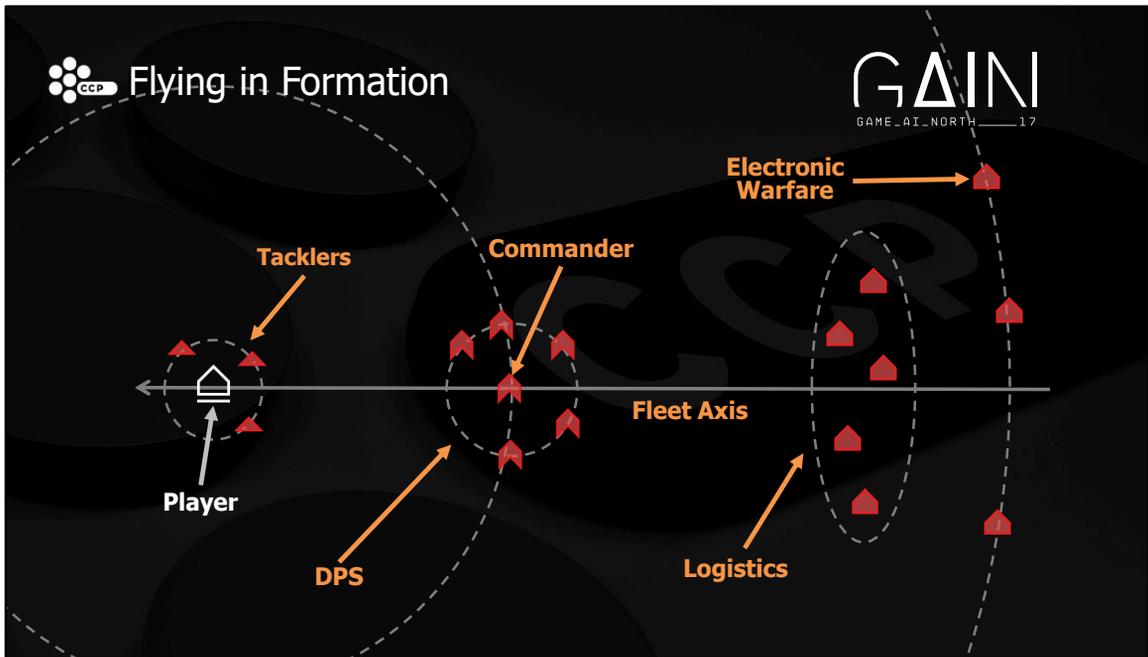


Flying in Formation

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This allows us to place the logistics behind the Commander and DPS away from the enemy.
within repair module range. They will try to stay on the fleet axis maintaining the right distance.



Finally we have the Electronic Warfare ships that will orbit targets and disrupt them as faraway as their EWar moduls allow. They tend to have very long ranges.

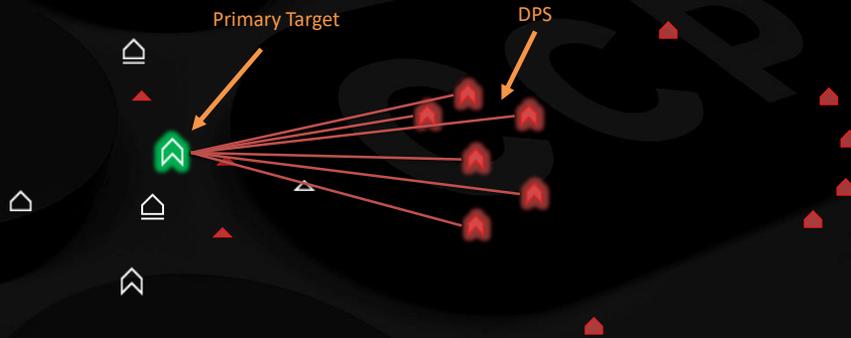
I have dubbed this the Wizardstaff formation



Differing Targeting Requirements

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- DPS: Attack Primary Target

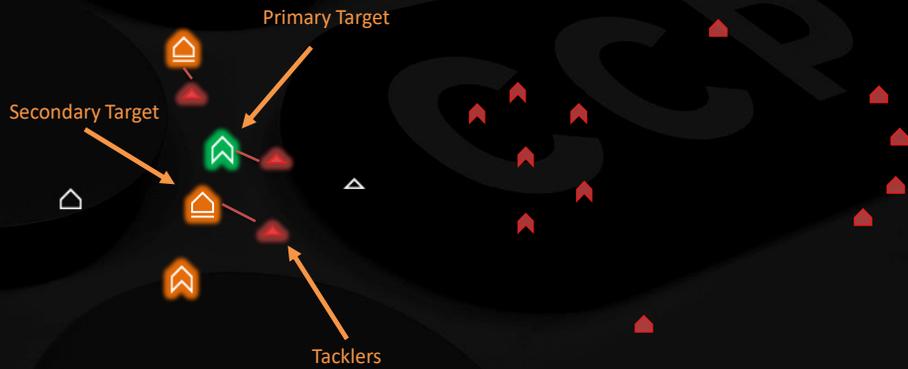




Differing Targeting Requirements

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- Tackler: Tackle Primary and Secondary

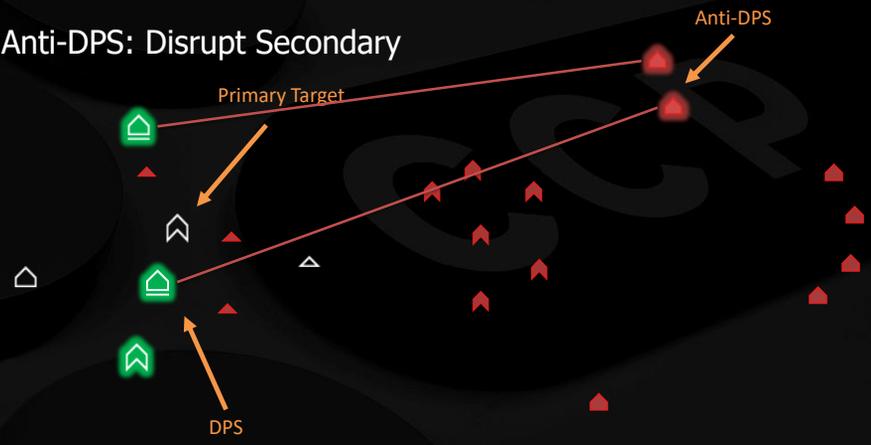




Differing Targeting Requirements

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- Anti-DPS: Disrupt Secondary





Differing Targeting Requirements

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- Anti-Logistics: Disrupt Logistics

Logistics



Anti-Logistics

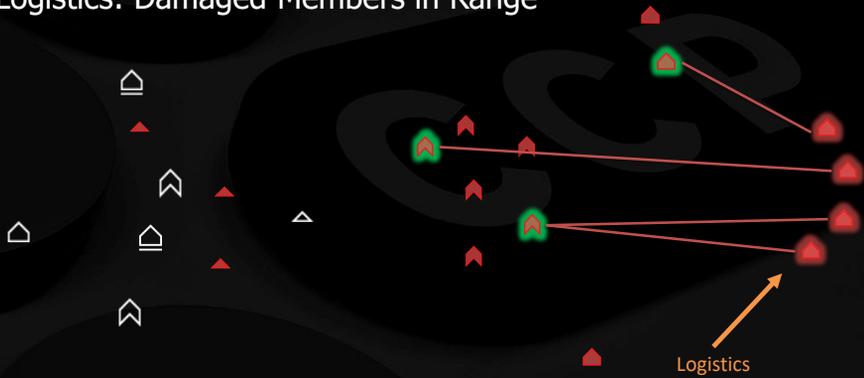




Differing Targeting Requirements

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- Logistics: Damaged Members in Range



Blood Raider Shipyards





Delivering High End Loot

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End of 2016 our designer pitched a relatively simple feature to deliver some high end player rewards.

We had these cool pirate capital ships but now good way of getting them into the game.

NPC Structures would be cool



- So lets spawn one of them cool new Engineering Complexes we just added to our game for our players to build capital ships.
- These are massive space stations more tha 100 km accross.
- The Avatar exiting there is supposed to be 13 km long for comparisson.
- So we took these player strucures and made NPC versions just like them except we add behavior trees and put got them reskinned.
- You can actually dock there and use the station facilities if you have the right roles.



Structure Modue Fittings

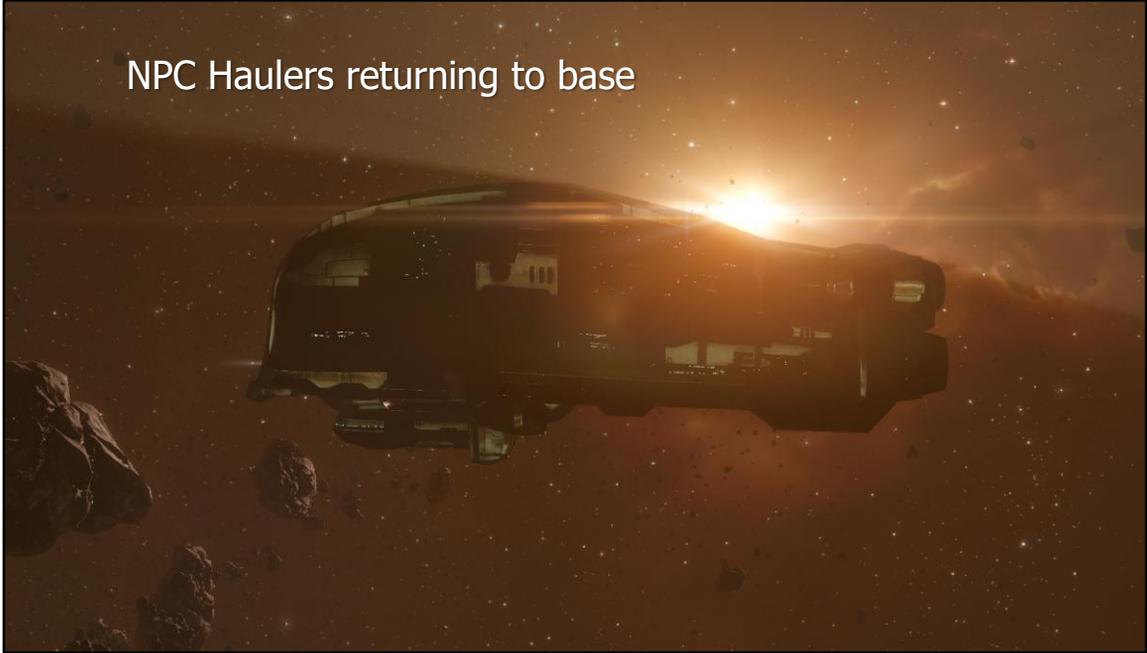
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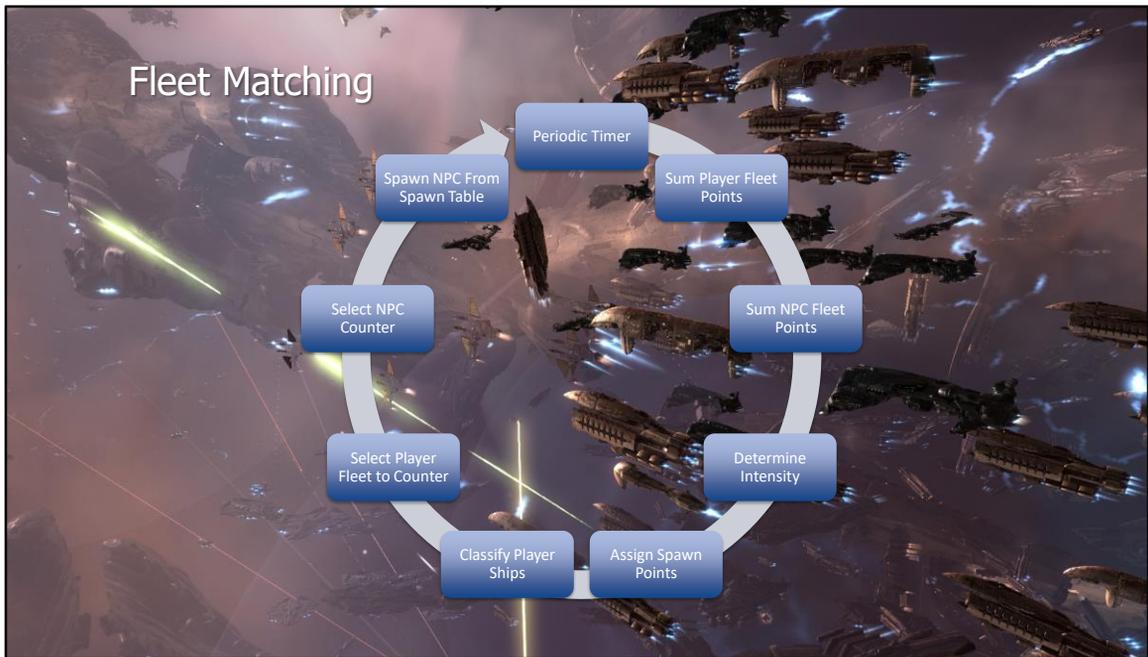
On top of that we spawned these as actual persistent, items complete with fittings like the players use.

The station will take part in the defense and spawned it's own defences fleets.

NPC Haulers returning to base



These structure where supposed to be super secret hidden pirate bases.
To begin with the only way to find it was to follow a Blood Raider Mining fleet hauler
back to base where it would dock up.



- That brings us to the fleet matching
- Every so many minutes the shipyard will analyse the battlefield and go through a series of steps to decide what to spawn.
- First we sum up the point cost of all the detected player ships.
- Then we do the same for all our currently surviving NPC defence forces
- We determine the current intensity we want
- And then assign missing points to spawn
- We pick a player fleet we want to counter
- Then select an appropriate counter to spawn
- Finally we spawn the reinforcements using spawn tables.

Fleet Matching

$$(\text{player_points} * \text{intensity}) - \text{npc_points} = \text{spawn_points}$$

This is how we determine how many points or reinforcements we need to spawn. Intensity is a multiplier we can drive dynamically.



Spawn Points

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Lets talk about spawn points

We created a new way to pick NPC combinations taking hints from our own Alliance Tournament

Where we already had created a system to assign point cost to ships to create a framework for balanced fleets players to fight competitively.



Spawn Points

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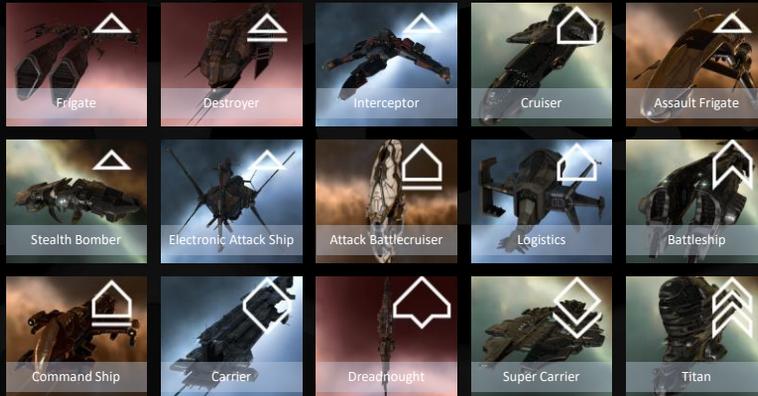


We have very large collection of player ships that we can expect to see.



Spawn Points

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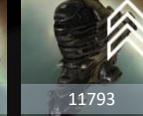


Each of these ships belong to a ship class and these ship classes are in general ment to be internally balanced.



Spawn Points

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 24	 33	 39	 45	 52
 54	 63	 100	 186	 195
 350	 1423	 2242	 7833	 11793

So we assign a cost to each of these ship classes.

As you can see they cover a very large spectrum from 24 points to nearly 12 thousand points.

These numbers are derived from the effective hitpoints of each ship and a class based multiplier.

And keep in mind that each of these ships are piloted by a single player.

So a group of 100 players can space anywhere from 2400 points to 118.000 points.

I wouldn't count on seeing 100 Titans very often as they represent huge in game investments.



Spawn Points

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8 x



=



11 x



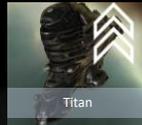
=



5 x



=



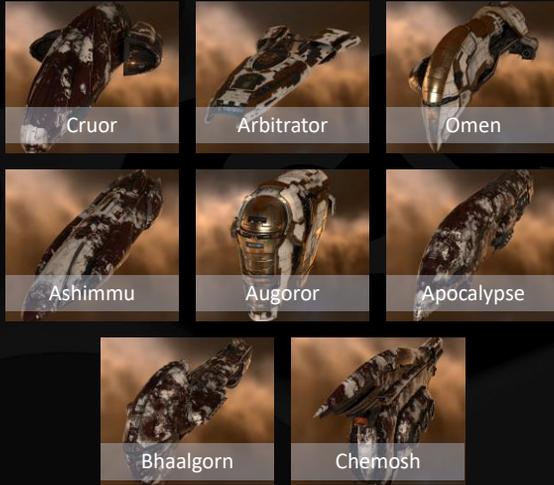
$8 \times 11 \times 5 = 440$

$11792 / 24 = 491$



Spawn Points

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For the Blood Raider NPCs we did the same thing



Spawn Points: Cost

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We calculate comparable point cost for each ship just like with the players ships.



Spawn Points: Tags

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We also added tags to each ship that we can use when selecting NPCs to spawn.



Spawn Points: Tags



Cruor



Arbitrator



Omen



Cruor



Bhaalgorn



Arbitrator



Ashimmu



Augoror

Short Range Fleet

Capital Fleet



Apocalypse



Augoror

Long Range Fleet



Chemosh



Chemosh

Using the tags we defined three basic fleet compositions
Short Range
Long Range
And Capitals



Spawn Points: Weights

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10



10



50



5



50



10



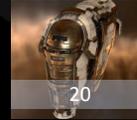
10



25



20



20

Short Range Fleet

Capital Fleet

Long Range Fleet



40



60

We also assigned weights to them so we could emphasis particular ships in our fleet compositions



Spawn Tables

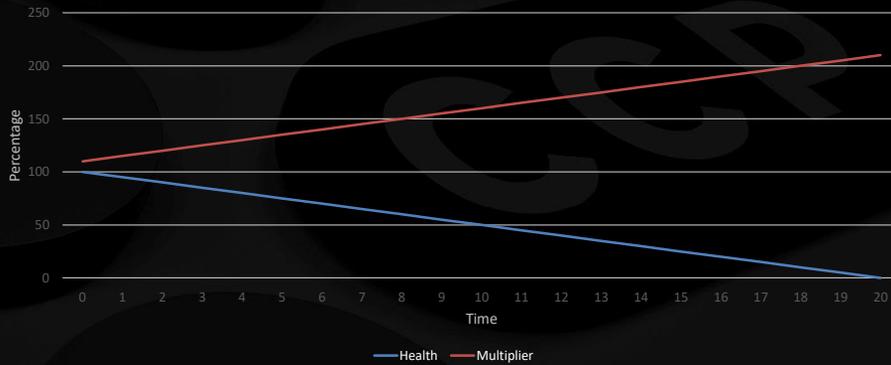


Type	Cost	Weight	Tags	Behavior
Cruor	29	10	Short Range	Tackler
Cruor	29	5	Long Range	Tackler
Omen	45	50	Short Range	DPS
Arbitrator	45	10	Long Range	Anti-DPS
Ashimmu	69	10	Short Range	Anti-Logistics
Augoror	132	20	Long Range	Logistics
Bhaalgorn	264	50	Long Range	DPS
Chemosh	2242	40	Capital	Anti-SubCapital
Chemosh	2242	60	Capital	Anti-Capital

We created spawn tables to encode all this where we could also assign behavior tree overrides

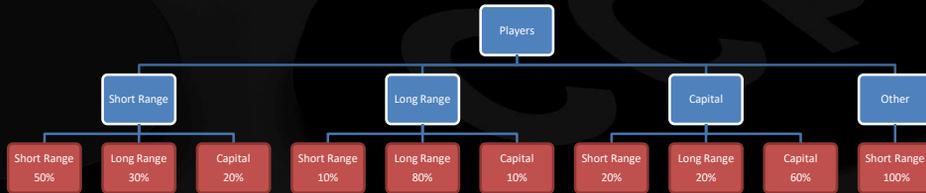
Allowing us to repurpose the same ship in different roles if we needed.

Spawn Point Multiplier



The intensity we used was directly proportional to the health of the structure be it status of shield, armor or hull

At full health we had 110% spawn points all the way to 210% when the health was depleting.



We used a simple decision tree to decide what counter to deploy.

We classified the enemies into 4 groups, Short Range, Long Range, Capital and Others

We did a weighted choice using the aggregated damage and healing done over a period by each group.

Then we had different weights for each of our 3 fleet archetypes based on what we were countering.

We wanted to keep a random element there as it makes the pirates less predictable and harder to exploit.



To make sense of the battlefield we developed system called Fleet Awareness
It's purpose is to simplify tracking of threats in proximity to our NPCs.



We have three separate NPC fleets

Using hierarchical cluster analysis we split the NPC into groups based on proximity.



Fleet Awareness

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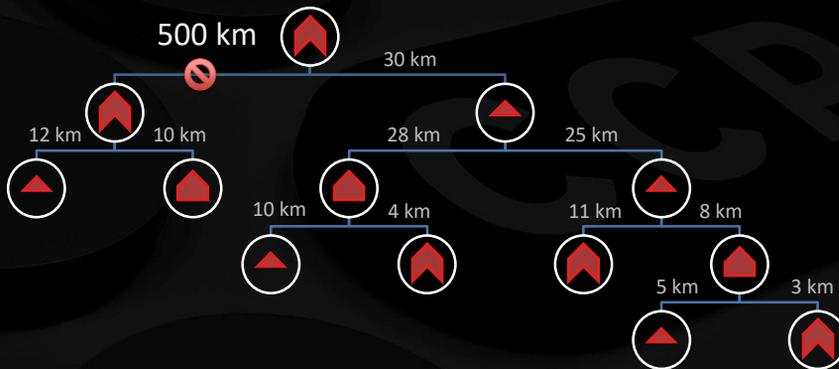


We use single linkage clustering for this as it has a very useful property.



Single Linkage Clustering

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The algorithm gives us a tree of how the clusters merge. The edges represent the distance to the nearest cluster.

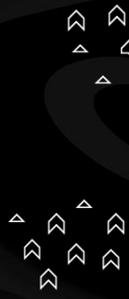
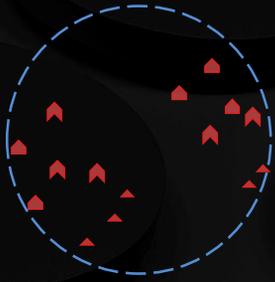
So given a threshold we can just walk down the tree and cut the edges that exceed our limit until we hit an edge that is under it.

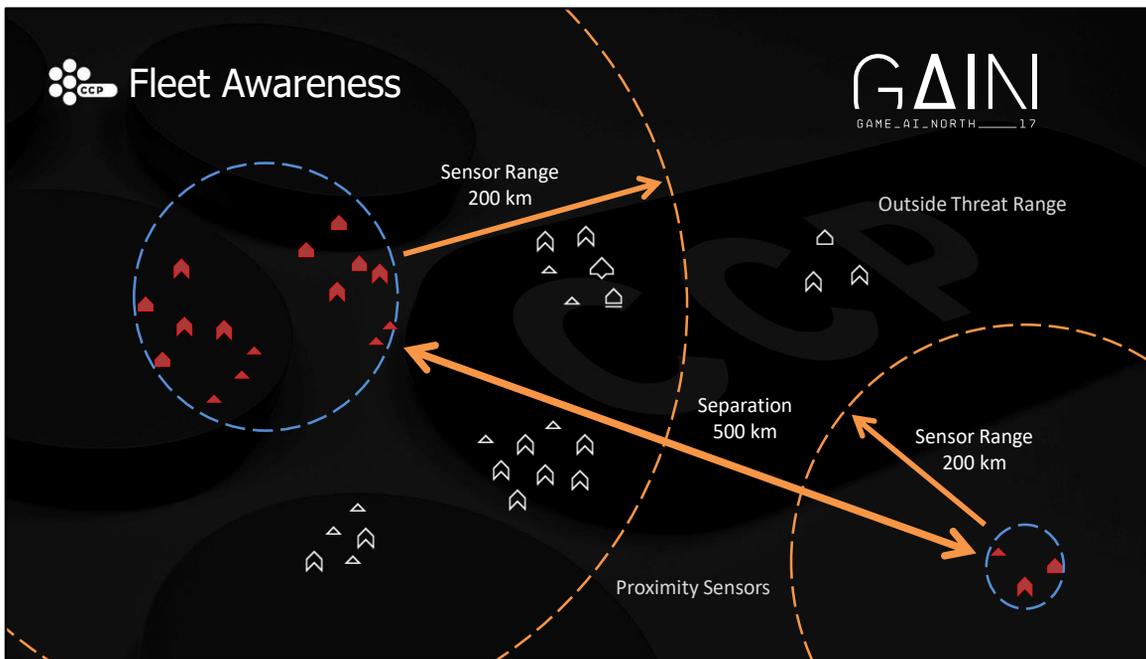
This way I can enforce a minimum separation between clusters. We end up with a variable number of clusters based on their separation.



Fleet Awareness

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Now I can easily that my sensors wont overlap
 and I can place a single sensor for each of my cluster as needed.
 These sensors get updated when the cluster members change or we detect a drift
 over some threshold.
 We only test the clusters every 10 seconds.
 The most expensive bit is computing the distance matrix between each NPC in the
 fleet.
 This is not time critical so we can update this in a pretty relaxed manner.



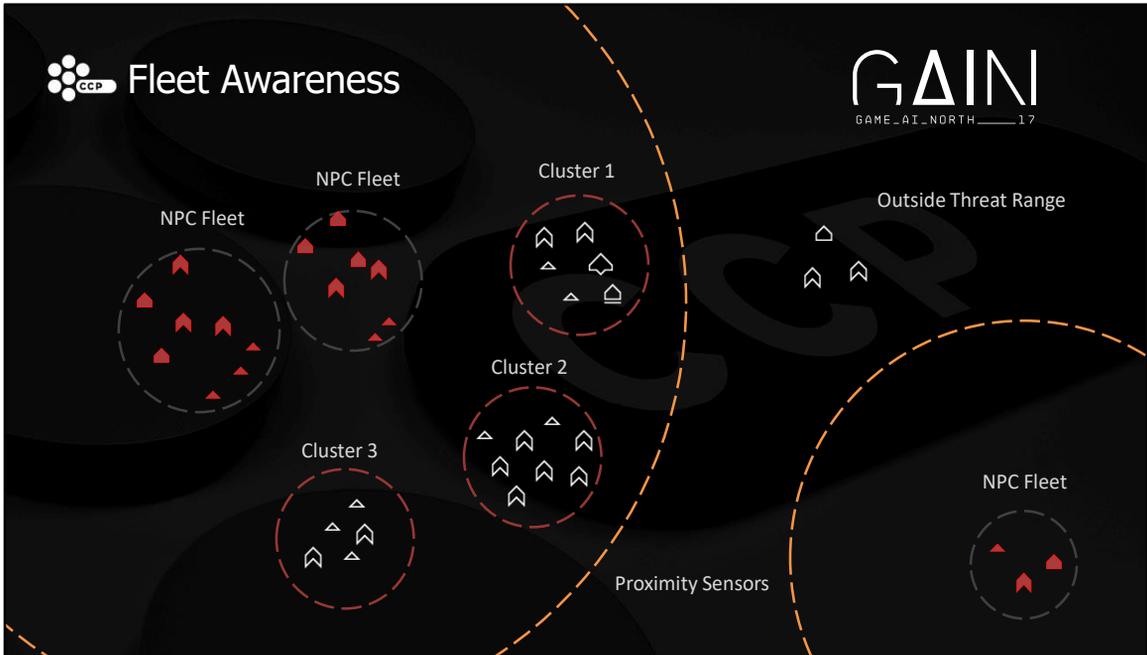
So here we have three NPC fleets and the sensor ranges they have.

Next we have to figure out where our enemies are and where to focus our efforts. It's really difficult to anticipate what the players are upto or understand what their strategy is.

And as soon as our player figure out how things work they are pretty good a trying to break it.

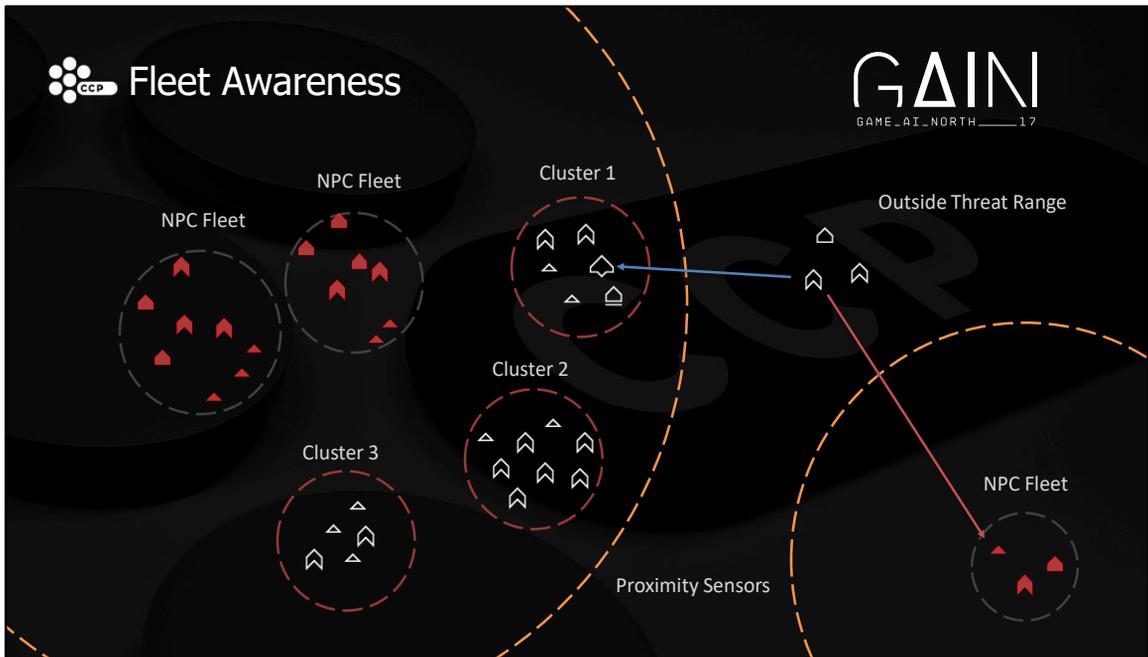
So we opted for a fairly simple approach again using hierarchical clustering to split the players into groups

We could

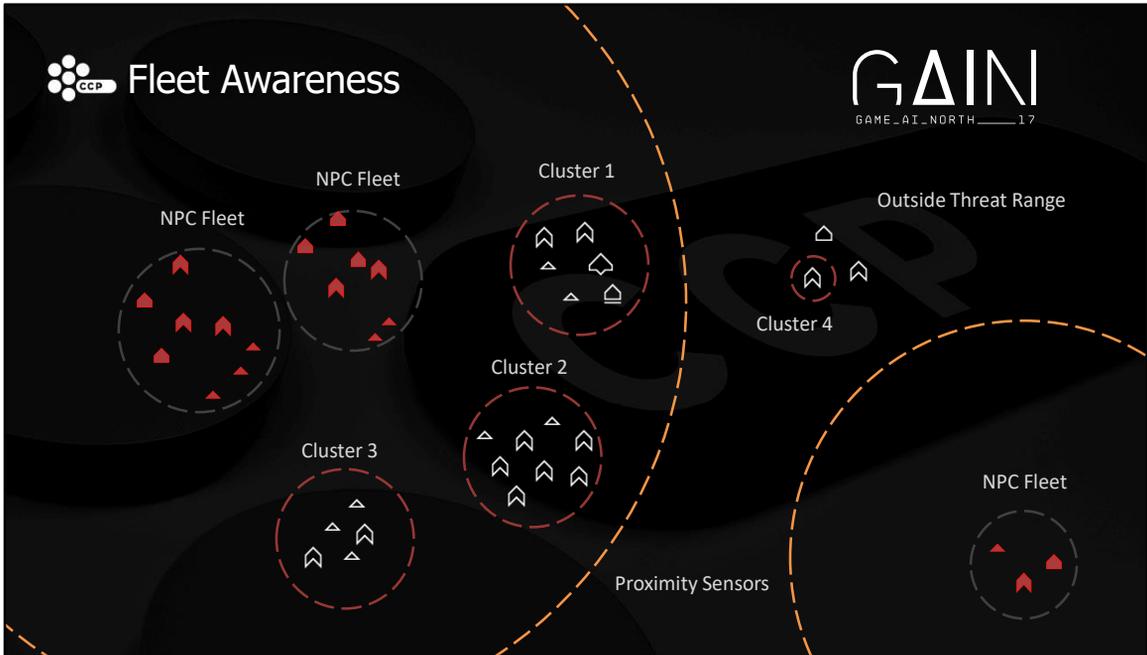


So we opted for a fairly simple approach. Again using hierarchical clustering to split the players into groups.

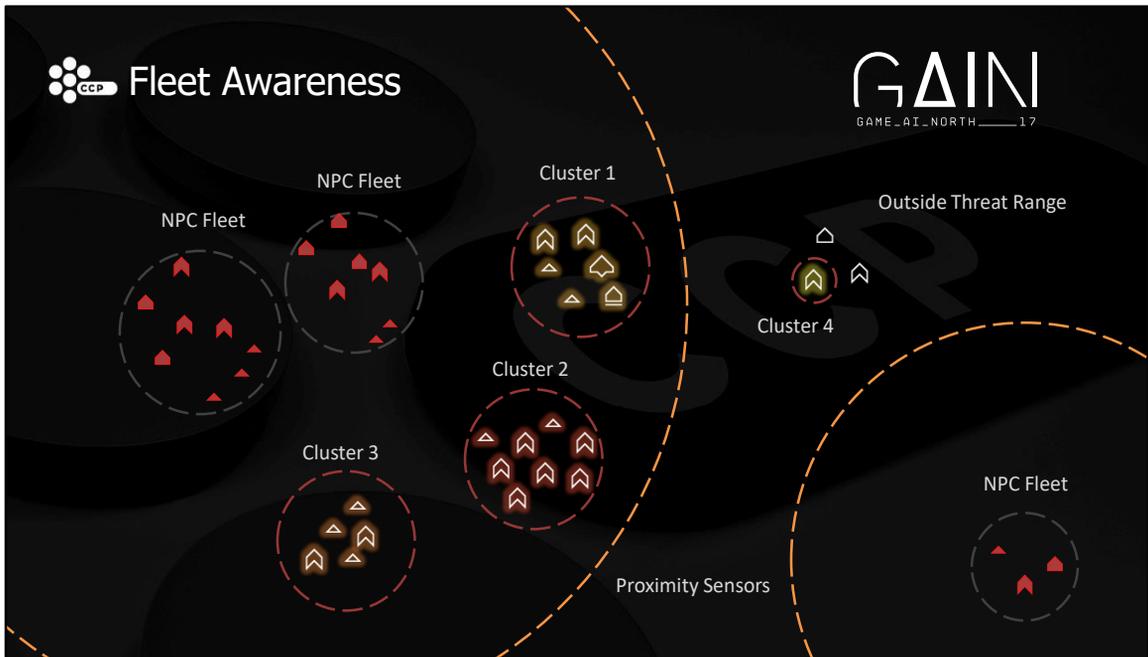
So every player ship with in our sensor range will be included.



If a player ship outside our sensor range attacks our NPCs or assists a player already tracked we add that ship to our threat list.

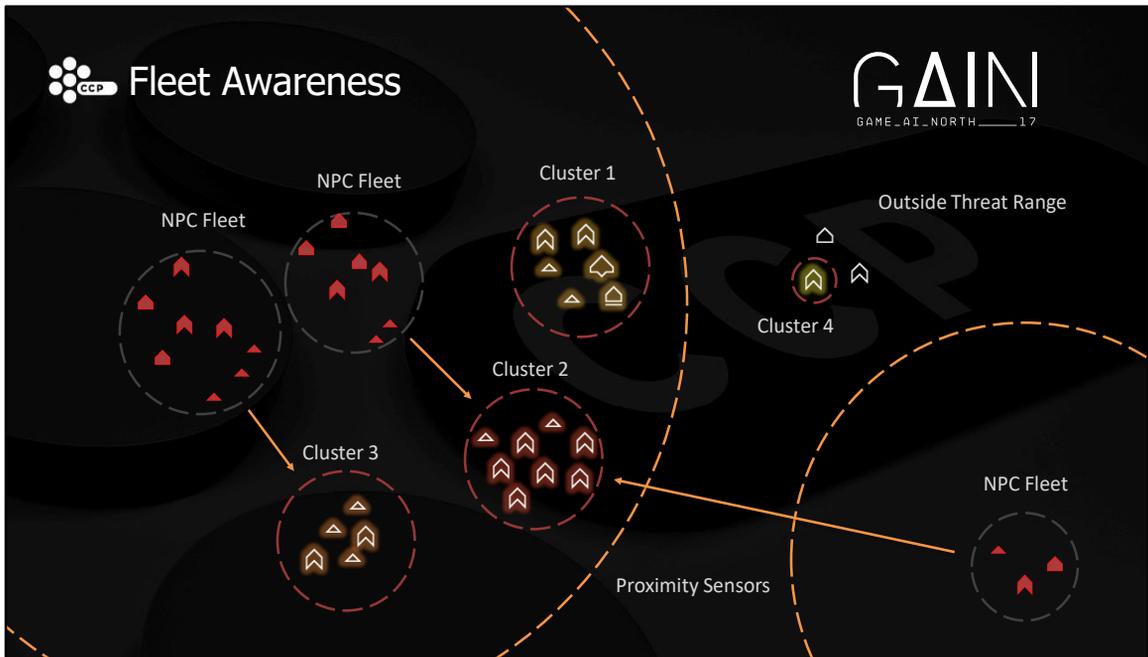


In addition we remember each threat for 15 minutes after they exit our sensors or offend us in any way.



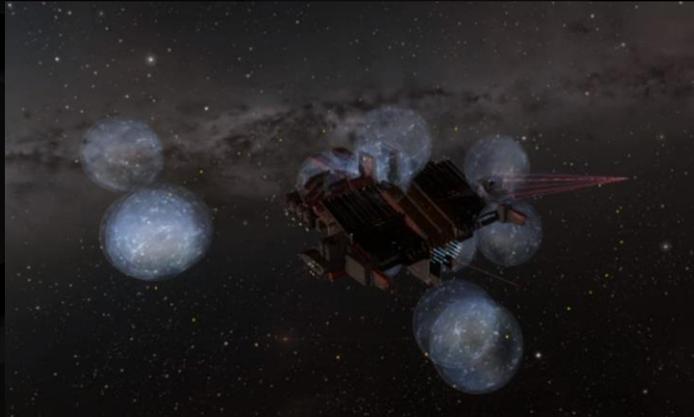
For each of these groups we rank them according to their combined damage and healing output over a period of time.

This gives us a threat value per cluster and each NPC group will then pick an enemy cluster using a weighted random choice.



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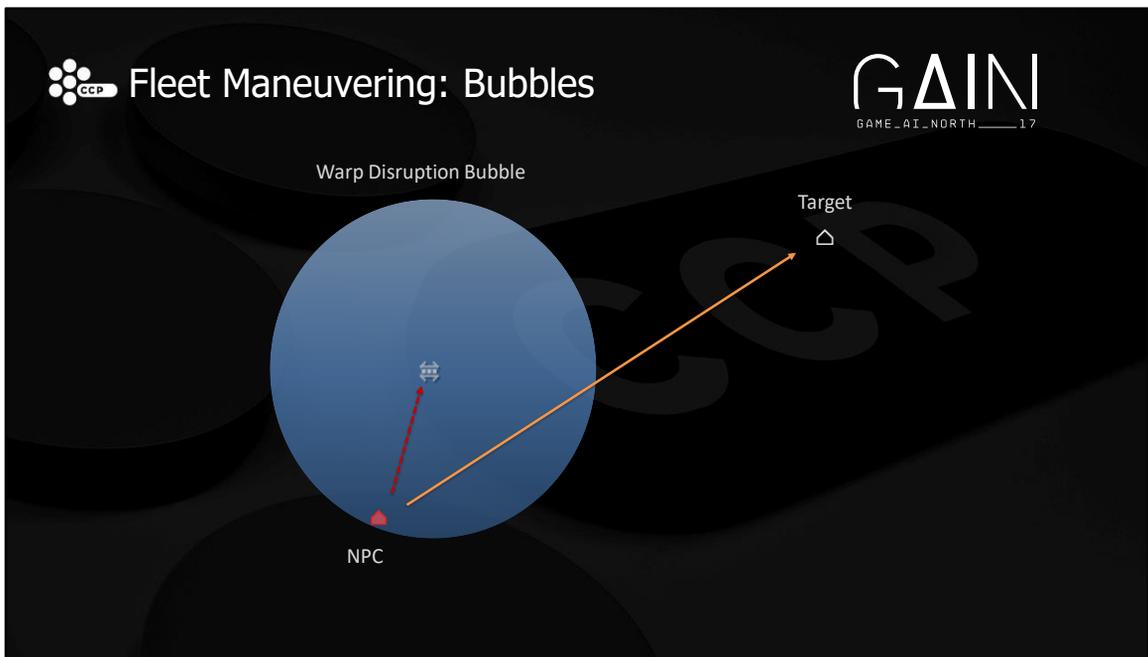
This gives us a threat value per cluster and each NPC group will then pick an enemy cluster using a weighted random choice.



We implemented so specific fleet maneuvers to deal with specific situations when moving around the battlefield.

To begin with we needed to be able to deal with Warp Disruption Bubbles that players can place in space.

As seen on this image here.



Warp Disruption Bubbles prevent anyone inside it from warping.

So if an NPC found itself inside one we had to deal with that.

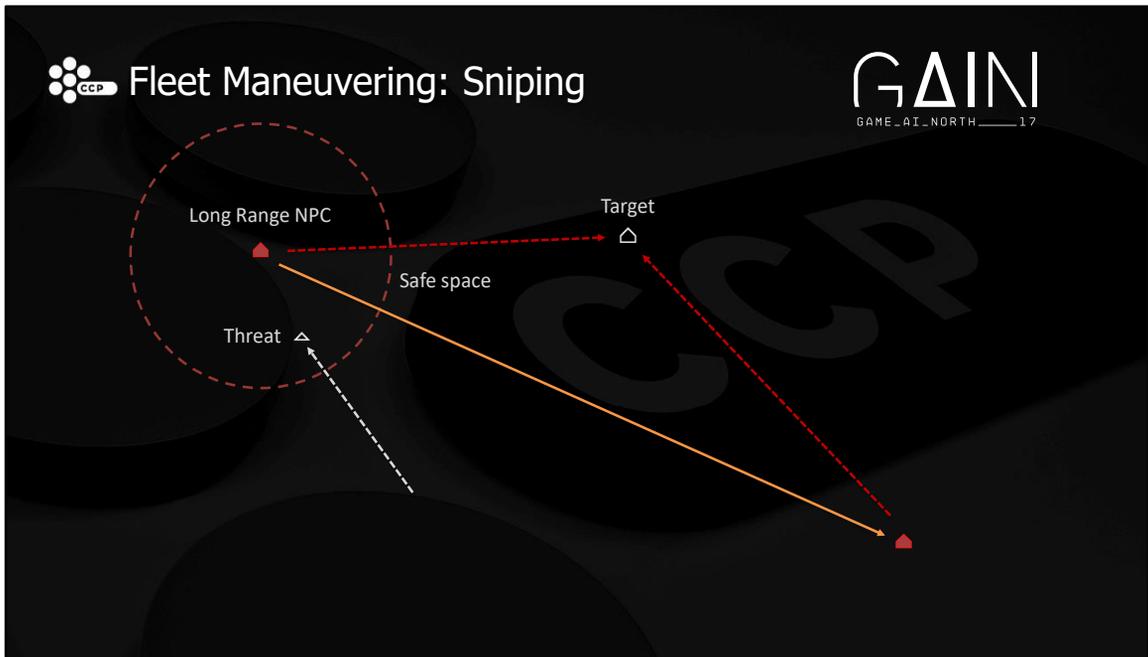
We opted for a fairly simple solution of just burning towards the intended target until we get out of the bubble.

In the meantime we will target and shoot at the Bubble Generator to try to take it out.

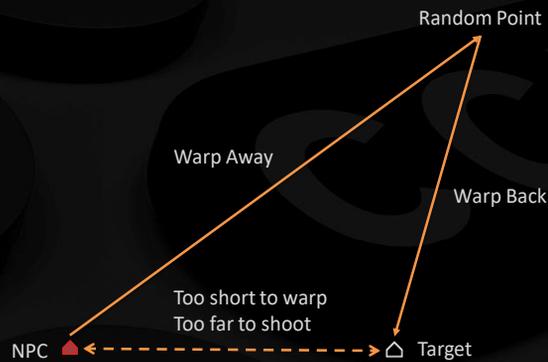


Fleet Maneuvering: Sniping

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Long Range Fleets have a sniping behavior where
If a threat gets too close they will relocate to a new sniping position
to avoid getting caught and pinned down.



Bouncing or Ping Warps are ways to quickly relocate on the battlefield. This will happen when NPC needs to get to a position too close to warp directly but too far away for weapon range to have any effect. The NPC will pick a random point several hundred km away and warp there before warping back the new destination. The effect in practice due to the random point is observed as starburst warping.



You should be watching the Orange brackets which are the pirates. Notice how they will often scatter in random directions and then converge again at a location. The red ships are super fast frigates orbiting and shooting the shipyard making very hard for our pirates to catch them and kill.

NOTE: through out the linked video you can see the AI ships repositioning. The segment I showed was around 24:30 into the video.
<https://youtu.be/fQlCeaHwGwY?t=24m30s>



Will you look at the time!

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CCP made SCOPE video release right after the first shipyard was put into reinforced mode

<https://www.youtube.com/watch?v=HIN973qCxyo>



Note from Freyr:

This is a recording of the Imperium Alliance taking down the Shipyard and the chaos that followed.

The whole scene is over an hour long.

The orange brackets are the AI controlled Blood Raider Defence Fleets

The red brackets are Imperium Alliance Player ships taking down the shipyard with mostly very fast cheap frigates.

The blue brackets are TEST Alliance Please Ignore and are there to harrass the Imperium and then steal their loot if they can. Which they did.

The gray brackets are 3rd player faction also there to mess with the Imperium.

The video starts as the Shipyard is exiting reinforced mode and starts spawning NPC AI ships.

The video ends with the Shipyard destruction and the subsequent sacking.

<https://www.youtube.com/watch?v=fQlCeaHwGwY>

<https://youtu.be/fQlCeaHwGwY?t=1m00s> exiting reinforced mode

<https://youtu.be/fQlCeaHwGwY?t=1h2m15s> Imperium reinforcements arrive right

before the Shipyard goes down to help control the battlefield and prevent enemies looting

<https://youtu.be/fQlCeaHwGwY?t=1h5m45s> The final destruction of the shipyard



Where's my loot?

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The first shipyard dropped a Titan and a Dreadnought blueprint
Those got snatched by a TEST pilots from the Imperium
That TEST pilot got shot down and the Dreadnought blueprint was destroyed but the Titan blueprint got picked up
By this other TEST pilot Hudders which also got shot down and the Titan blueprint was also destroyed.
So nobody got the juicy loot that time.
Next time the shipyard got completed the Molok Titan blueprint dropped but got stolen by a friendly and auctioned off for vast sums of Internet Space Credits.



From hundreds to a few

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- 500-600 players involved in first shipyard
- NPC shipyard destroyed ever 1 – 2 weeks
- 9-10 Super Carriers



Where do we go from here?

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- More Shipyards with different factions
- Scaling down the content
- Adding more fleet archetypes to counter with
- Better analyzes of player doctrines and behavior
- Formalizing Fleet Counters
- Improve Target Management
- Improving Fleet Navigation and Maneuvering
- Unifying behavior trees and configure dynamically

We are now expanding the content to more factions and space in game.

We are scaling the content down and making it more accessible

We have started formalizing the fleet counter mechanics and moving that into tabular structured form.

We need to flesh out more counters and more fleet archetypes so we can deal better with specific player doctrines.

We need to work on our targeting management to deal with all the different requirements different roles have

We need to work on our navigation systems to simplify behaviors and make them more robust.

We need to unify our behavior trees and find better ways to parametrize them and give context.

We need to work on our ability to read the battlefield and give context to spawn mechanics and behavior.



Questions and Answers?

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